Vol. 60 FEBRUARY, 1933 JAN 20 1933 No. 2

Bulletin

of the

Torrey Botanical Club

Editor
Bernard O. Dodge

Associate Editors

John Hendley Barnhart
Albert Francis Blakeslee
Cornelia Lee Carey
Frank Earl Denny
Alexander William Evans
Henry Allan Gleason
Arthur Harmount Graves
Alfred Gundersen
George Tracy Hastings
Tracy Elliot Hazen
Marshall Avery Howe
Louis Otto Kunkel
Michael Levine
Arlow Burdette Stout
Sam F. Trelease
William H. Weston, Jr.

CONTENTS

A Protolepidodendron from the Devonian of Virginia ..... *Edward W. Berry* 73

The relation of host and pathogen in Ustilago Avenae: a reply ..... *A. Zade and A. Arland* 77

The production of vestigial and sterile sex-organs through sex-reversal and neutral sexual states ..... *John H. Schaffner* 89

Studies of South American plants. III. New Ericaceae and Vacciniaceae ..... *Albert C. Smith* 99

Index to American Botanical Literature 122

Published for the Club monthly except
July, August, and September
by
GEORGE BANTA PUBLISHING COMPANY, MENASHA, WISCONSIN

Subscription price $6.00 per year

Entered as Second Class Matter at the Post Office at Menasha, Wisconsin
Accepted for mailing at special rate of postage provided for in the act of February 28, 1925, embodied in paragraph 4, section 412, P. L. and R., authorized July 23, 1928.

THE TORREY BOTANICAL CLUB

President
ALBERT FRANCIS BLAKESLEE, PH.D., D.Sc.

Vice-Presidents
HENRY ALLAN GLEASON, PH.D.
ROGER PHILIP WODEHOUSE, PH.D.

Secretary
FORMAN T. McLEAN, PH.D.
New York Botanical Garden, Bronx Park, New York, N.Y.

Treasurer
MRS. R. A. HARPER, M.A.
Schermerhorn Hall, Columbia University, New York, N.Y.

Editor
BERNARD O. DODGE, PH.D.

Bibliographer
JENNIE S. DODGE

MEETINGS

Meetings twice each month from October to May, inclusive: the first Tuesday at 8:15 P.M., at the American Museum of Natural History or at Columbia University; the third Wednesday at 3:30 P.M., in the Museum Building of the New York Botanical Garden, Bronx Park, New York, N.Y.

PUBLICATIONS

All subscriptions and other business communications relating to the publications of the Club should be addressed to the Treasurer, Mrs. R. A. Harper (mail address, Schermerhorn Hall, Columbia University, New York, N.Y.). Matters relating to advertisements and circulation should be referred to Dr. Michael Levine, Montefiore Hospital, New York, N.Y. All communications regarding exchanges should be referred to the Exchange Committee, consisting of the Librarian of the Columbia University and the Librarian of the New York Botanical Garden.

Bulletin. Established 1870. Monthly, except during July, August, and September. Price, $6.00 a year; single numbers 75 cents. Of former volumes, only 24–56 can be supplied separately; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Manuscripts intended for publication in the BULLETIN should be addressed to Dr. B. O. Dodge, New York Botanical Garden, Bronx Park, New York, N.Y. The editors may accept papers up to 20 pages in length, with illustrations and tabular matter generally not exceeding twenty per cent of that amount. Longer and more copiously illustrated papers, however, may be published if the excess pages, illustrations, and tabular matter are paid for by the contributors.

Torreya. Bimonthly, established 1901. Price, $1.00 a year. Manuscripts intended for publication in TORREYA should be addressed to Mr. George T. Hastings, Editor, 2587 Sedgwick Ave., New York, N. Y.

Memoirs. Occasional, established 1889.

Preliminary Catalogue of Anthophyta and Pteridophyta within 100 miles of New York City, 1888. Price, $1.00.

Reprints. Contributors of articles accepted for publication in the BULLETIN should order reprints, if desired, when they return galley proofs to the editor. They may be ordered through the editor from the George Banta Publishing Company, the contributor paying for all his reprints. A schedule of rates is sent with galley proof.

A Protolepidodendron from the Devonian of Virginia

EDWARD W. BERRY

(WITH PLATE 7)

There came into my hands during the past summer a small collection of plant material from the Devonian at an exposure 3½ miles west of Covington, Virginia, and just west of a road-pass bridge over the Chesapeake and Ohio Railroad right of way. At this locality there is a considerable thickness of littoral or continental beds which lie near the boundary between the middle Devonian Romney formation and the upper Devonian Jennings formation.

This collection was made by Brinton H. Stone, who is making a study of the Devonian of that region. The collector is inclined to refer the plant horizon to the top of the Romney rather than to the base of the Jennings because it lies some distance beneath a dark fissile shale similar to one which in the Maryland region is referred to the Genesee member of the Jennings. It may be said that the lithologic and to a considerable but much less extent the paleontologic expression of the middle and upper Devonian from Maryland southward differs from the New York standard section, so that it has not been possible to recognize the numerous formational units of the latter with any degree of precision, although there is sufficient paleontologic evidence in the southern region to show that the Romney formation (Darton 1892) represents the time of the Onondaga, Marcellus and Hamilton of the New York section, and that the Jennings (Darton 1894), at least in Maryland, with its four members, represents all or in part the Genesee, Ithaca, Portage and Chemung of the New York section.

It is *a priori* highly improbable that the recognized members of the Devonian in Maryland and the Virginias with their varying lithology and thicknesses are the exact equivalents of the formations with which they are correlated in New York, and there is a certain amount of field evidence that such is not the case. This brief resume will serve as an introduction to an account of the most interesting plant fossil from near Covington, Virginia, which is a considerable cortical fragment of what White described[1] in great detail in 1907 as *Archaeosigillaria primaeva* and which was based upon the remarkably preserved fossil from the Hatch shale near Naples, N.Y., a splendid restoration of which is on exhibition in the State Museum at Albany. This unique specimen is usually called the Naples tree, although it was found in the upper Portage Hatch shale and is therefore well up in the upper Devonian, the name Naples being used in a geographical and not in a stratigraphical sense.

[1] White, D., N. Y. State Museum Bull. 107: 327–340, *pls. 1–11*, 1907.

[THE BULLETIN FOR JANUARY (60: 1-72) WAS ISSUED DECEMBER 31, 1932.]

It was considered by White to belong to the same species that Henry D. Rogers described[2] in 1858 from his Cadent upper black slate at Standing Creek just east of Huntingdon, Pennsylvania as *Lepidodendron primaevum*, and which was illustrated by an extremely poor woodcut.

The horizon from which it came is usually assumed to be of Marcellus age, and in any event it is considerably older than the New York specimen. Without going into the question of the nomenclatorial history it may be pointed out that many if not all of the Devonian specimens which the older students referred to *Lepidodendron* represent more primitive types. This has been recognized by several more modern students, and Krejci in 1879 proposed the term *Protolepidodendron* for a Bohemian form which came from the Givetian stage of the Devonian, i.e. to the upper middle Devonian. Subsequently Kidston (1901) proposed the genus *Archaeosigillaria* for *Lepidodendron primaevum* Rogers and *Lepidodendron vanuxemi* Goeppert, the latter being recorded from England, and also probably occurring in Germany.[3] Both genera are not precisely delimited and one or the other has been recorded from other regions, Walkom, for example, describing a *Protolepidodendron* from New South Wales. In the absence of proof of distinctness between *Archaeosigillaria* and *Protolepidodendron*, and the general unsatisfactory nature of much of the material, I prefer to use the older name of *Protolepidodendron*, which becomes the type of a distinct family, and the species under discussion becomes *Protolepidodendron primaevum* (Rogers) Berry, 1920.

The principal specimen (plate 7) is on a weathered fragment of drab shale. It shows a cortical fragment 17 centimeters long and about 6 centimeters in width. There are some indications of decay at the lower left and upper right, but I am not certain that this appearance is due to maceration before fossilization or weathering of the soft material while the surface of the piece of shale was exposed to the elements. The upper right area simulates a Knorria stage, but opposed to this are faint indications of attached leaves on both edges in the median part of the specimen, which would scarcely be consonant with a Knorria condition just above. On the other hand I have a small fragment and its counterpart from the darker unweathered shale at this outcrop which is a typical Knorria stage of this species, and which agrees exactly with the Knorria condition of the Naples tree figured by White on his plate 10, figure 1.

The larger specimen shows the fusiform, lepidodendroid scars very similar to the segment figured by White on his plate 11 which came from

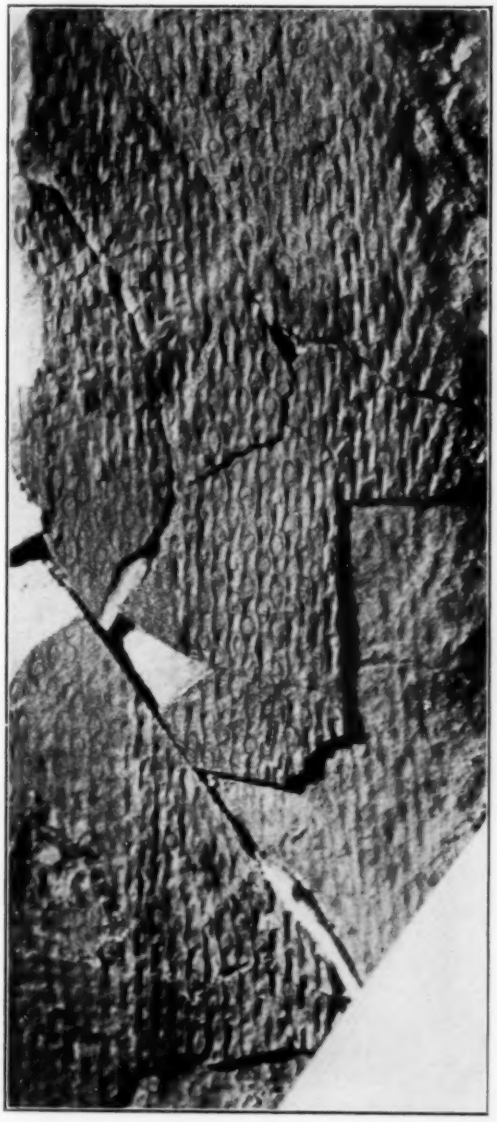
[2] Rogers, H. D., Geol. of Pennsylvania. 2[2]: 828. f. 675. 1858.

[3] It is mentioned by Hume (Quart. Jour. Geol. Soc. London 88: 369. 1932) as present in southwestern Egypt, but the specific identity may well be questioned.

near the top of the Naples trunk. The Virginia specimen, however, evidently came from nearer the transitional zone of the trunk where the sigillaroid passes into the lepidodendroid form since the arrangement is not completely spiral. The preservation is not quite so good as in the New York specimen and the detailed markings of the leafscars can not be made out.

I think there can be no question but that the present material represents the same species as does the Naples tree. It is a matter of considerable interest that this, probably the largest preCarboniferous Lepidophyte, should be shown to have had such a geographic range, and it is still more interesting that it should have such a considerable stratigraphic range. Whatever the ultimate decision as to the exact horizon of the occurrence near Covington, it is obviously older than the Pennsylvania and New York occurrences, even granting that there is doubt as to whether it comes from the upper Romney or lower Jennings. If the Romney alternative proves correct it shows the presence in the middle Devonian of a primitive but rather large Lepidophyte almost as old as the middle Devonian Psilophytes (*Psilophyton*, *Rhynia*, *Hornea*, *Asteroxylon*) which have made such a stir in paleobotanical circles during the last few years. I realize, of course, that calling a fossil middle Devonian instead of upper Devonian does not alter its actual position in the stratigraphic column, but as long as men are obliged to use names and as long as geologists persist in laying so much stress on artificial time units, and correlate these units and their contained faunas and floras, just so long will the name of the unit seem more important than it really is. No other determinable plants have as yet been found associated with *Protolepidodendron primaevum* near Covington. There are a few undeterminable Lepidophyte leaves that might well belong to this same species and a parallel veined fragment that might represent a Devonian representative of the Cordaitales, but which is not certainly determinable.

Johns Hopkins University



BERRY: PROTOLEPIDODENDRON

UNIV. OF MICH.

The relation of host and pathogen in Ustilago Avenae: a reply[1]

A. Zade and A. Arland[2]

At the Institute of Agronomy and Plant Breeding of the University of Leipzig we have been engaged for a number of years in intensively investigating the life cycle of the loose smut of oats, *Ustilago Avenae*, in the development of methods for causing infection of oat seeds with loose smut mycelium, as well as in testing varietal immunity and fungicides. The impetus to investigate these problems was given by the important demonstration by Zade,[3] published in the year 1922, that, in the case of loose smut of oats, there is a peculiar kind of blossom infection, in which the spores get into the opened flowers of neighboring plants through the agency of the wind, during the flowering period, germinate on the stigmatic branches, and form mycelium that penetrates into the glumes and gradually develops into a resting mycelium. This discovery was fully confirmed by Arland,[4] Diehl,[5] and Rösch[6] in the years immediately following; and it was possible to amplify it by showing that the mycelium not infrequently attacks the outer coat of the caryopsis also, to persist here in the resting condition. Furthermore, resting mycelium was demonstrated in and on the remnants of anthers and stigmas that remained between the glumes. The spores that fell directly on the ovary during the flowering period and germinated there produced mycelial threads that appeared as if interwoven with the pubescence of the ovary. These resting mycelia, especially, however, that in the parenchyma of the outer glumes, were recognized by us as the actual infection center that must be rendered harmless by means of pickling, while previously it was assumed that it was a question of rendering the spores non-viable through pickling. We did not reject immediately as erroneous the still occasionally recurring

[1] Contribution from the Institute of Agronomy and Plant Breeding of the University of Leipzig.

[2] In translating this paper I have tried to make a fairly literal translation. Obviously, smoothness has been sacrificed.

"Beizen" has been rendered by "pickling," the English expression for treating seed. Again, "infizieren," which is used in the paper both in the sense of "to inoculate" and "to infect," has been translated in both ways in various places, depending on the meaning which the authors apparently had in mind.

Dr. Ernst Artschwager has been kind enough to compare the translation with the original and to make some improvements.—E. C. Stakman.

[3] Fühling's Landwirtschaftl. Zeitg. **71**: 393–406, 1922.

[4] Bot. Arch. **7**: 70–111, 1924.

[5] Bot. Arch. **11**: 146–199, 1925.

[6] Bot. Arch. **13**: 382–432, 1926.

opinion that non-germinated spores remain between the glumes and the caryopsis, and that they do not germinate until spring, after the sowing of the oat seeds, with which they germinate simultaneously; but yet it is established by our investigations, extending over many years, that spore germination in the spring can not be of appreciable importance because the viable spores germinate almost entirely at blossoming time, so that in the following spring—that is, at the time of sowing the oats—there are no, or, at most, only very occasional, non-germinated but yet viable spores within the oat seeds.[7] Exact investigations have shown in noteworthy manner that almost all spores—indeed all, without exception—that are found between glumes and caryopsis are non-viable.

As we have been able to show conclusively, the infection of the young oat seedling proceeds from the mycelium present in the peripheral layers of the oat seed, whether it be in the parenchyma of the glumes or in other peripheral places. In the case of loose smut of oats, therefore, we are dealing, in addition to blossom infection, with a seedling infection also—a process which Zade designated "blossom and seedling infection" and which one could call "blossom infection in the sense of Zade," in contrast to that in wheat and barley, i.e., "blossom infection in the sense of Brefeld." This proposal is the more justifiable because Zade first called attention to this peculiar kind of blossom infection and, incidentally, discovered it at the same time for loose smut of barley, and, in agreement with Vogt,[8] for the barley stripe disease (*Helminthosporium gramineum*).

The occurrence of this briefly described new type of floral infection has been confirmed recently in the United States also, by Gage.[9] He obtained 67 per cent of smutted plants by inoculating oat flowers by dusting with spores. According to him the resting mycelium found in the pericarp of the caryopsis is primarily responsible for the infection of the seedlings. Furthermore, Kathleen Sampson[10] demonstrated the resting mycelium in the glumes of artifically and naturally inoculated oat flowers. The importance of the resting mycelium for the overwintering of the fungus, and therefore for its life cycle, is substantiated especially by the fact contributed by Kathleen Sampson,[11] that the spores of *Ustilago Avenae* collected at the flowering time of oats in June, lose their viability very rapidly. According to her observation, only the completely matured spores, collected in June —that is, a considerable time after blossoming—remain viable for years.

[7] "Haferspelzfrüchte" in original; the entire fruit is meant.

[8] Arb. a.d. Biolog. Reichstanst. f. Land- u. Forstw. **11**: 387–397, 1923.

[9] Cornell University, Agr. Exp. Sta., Mem. 109: 3–35. 1927.

[10] Ann. App. Biol. **16**: 65–85, 1929.

[11] Ann. App. Biol. **15**: 586–612. 1928.

In the following spring, according to Sampson and according to our results, an infection of the oat seedlings proceeds from the resting mycelium, while, as stated, the spores which may still be present on the caryopsis are the non-viable ones.

With the investigation of the mode of life of the fungus, however, only a part of the problem was solved. It was necessary, now, to evolve methods that made it possible to obtain, in a short time, independently of weather conditions, large quantities of certainly and uniformly infected oat seeds which are suitable for pickling experiments and for the determination of varietal immunity. The dusting of the open oat flowers with loose smut spores would be the most natural method to obtain the required infected seed material. Because of the great laboriousness, however, this method can not be used practically. As the oat flowers are open only a short time, and in cold, wet weather—at least under the climatic conditions of Germany—occasionally are not opened at all, far fewer infected kernels than are necessary for pickling and resistance investigations on a field scale can be obtained in one year, despite the activity of numerous people. The goal is reached more easily, as has been shown by investigations over a period of years, if the spores are artificially introduced between the glume and kernel and induced to germinate here. Various methods were tried before we were finally successful, after much work, in introducing the spores in a very simple manner, by suction, between glume and kernel, and to produce the mycelium here.[12,13] The method designated as "the evacuation method," and now more completely elaborated, makes it possible to infect almost unlimited quantities of oat seed easily with loose smut in the shortest time.

In an article that appeared in the Bulletin of the Torrey Botanical Club **57:** 443–507, 1930, L. A. Kolk discussed our investigations and says, Zade and his students "have neglected to emphasize that even the early investigators of flower infection recognized that the form of the old *Ustilago Carbo* Tulasne on oats, now called *Ustilago Avenae* (Pers.) Jens., did not fit perfectly into the category either of a seedling infecting or flower infecting smut. Brefeld and Falck (1905) and Falck (1908), whose work will be reviewed later in more detail, were well aware that flower infection was possible." (p. 444.)

In this connection it may be observed that the question raised by the authoress was not particularly mentioned in the works of Zade and his students because every one conversant with the literature on loose smut of oats must know that all the observations and conclusions pertaining to the

[12] Pflanzenbau **5:** 43, 1928/29.

[13] Bot. Arch. **29:** 444–473, 1930.

old form of *Ustilago Carbo* Tulasne can be accepted only with great caution, because it was a case of a collective group which comprised the most diverse smut fungi and therefore was not infrequently the cause of confusion in the literature. Aside from this, there was no reason to go into this fully, because even the purposefully undertaken investigations of Brefeld and Falck with loose smut of oats did not lead to a solution of the problem. That Brefeld was convinced of the possibility of blossom infection is clear from his publications. Actually, Zade also called attention to this, even in his first publication.[3] Furthermore, Arland discussed this fully on page 78 of his publication. The same applies to the conclusions of Falck. (See page 79 of the publication by Arland.) It is therefore incomprehensible how the authoress arrived at the assertion that Zade and his students "have overlooked especially the work of Falck in raising this question as to the place of entrance of *Ustilago Avenae* into the oat plant, . . ." (p. 445).

The view of the authoress, also, that the percentage of infection obtained by Zade and his students was in general very low when mycelium was placed between the glumes of the oat seeds or upon the epidermis of the naked kernels must be contradicted. She has overlooked the fact that since the work of Tamme, published in 1927, there are further contributions, according to which "intricate" inoculation methods are not necessary and the mycelium produced between the glumes of the oat seeds does not fail to cause heavy attack. In this connection is meant first of all the publication of Zade in "Pflanzenbau" of the year 1928/29; furthermore there are the more recent investigations of Haarring in "Bot. Archiv." Bd. 29, Heft 3/4, 1930 (appeared July 8, 1930) and in "Pflanzenbau" of the year 1930. The publications mentioned describe a very easy way which makes it possible to infect large quantities of seed with loose smut mycelium in a very short time. The method described in these publications is the "evacuation method" that has been mentioned and consists, briefly stated, in the removal by suction of the air present between glume and kernel and by the subsequent inflow of a spore suspension to permit the spores to penetrate summarily between the glumes and the kernel proper of the oat seed. In order that the spores may germinate within the glumes, oxygen is necessary, which is most easily attained by means of drying the seeds for a short time. This brings about the result that the moisture which has penetrated between glume and kernel with the spore suspension disappears and in place of it air penetrates between the glume and the kernel. Subsequent spreading of the infected seeds on moist blotting paper in a moist room suffices for the rapid development of resting mycelium. Seeds inoculated by means of the evacuation method can produce 80 to 100 per cent of diseased seedlings with proper handling. If seed inoculated in this

manner occasionally shows lower infection under conditions in the field, the inoculation method as such is not to be held responsible but rather the environmental conditions prevailing at the time of germination and infection. The authoress has therefore arrived at conclusions which, in consideration of our more recent investigations, are erroneous throughout. In addition, she did not take into consideration that inoculation methods can be developed only through protracted, fundamental investigations and much experimentation. It can not be immediately expected, therefore, that our contributions which appeared in the earliest years should furnish a complete solution of the difficult problem of the development of mycelium in a ripe oat seed.

In another connection the authoress briefly describes the new type of blossom infection. She mentions the fact that the fungus, instead of penetrating directly to the embryo, attacks principally the glumes and the epidermis of the ovary at flowering time, and later infects the young seedling that develops from such kernels. She adds, word for word: "If these claims are true, the validity of tests hitherto made for varietal resistance and susceptibility of oats to loose and covered smut (Reed, 1925a), and also tests of disinfectants used in seed treatment (Tisdale, Taylor, Leukel, and Griffiths, 1925; Leukel, 1926), where the method of dry spore inoculation has been practiced, are brought in question." (p. 444.) The authoress calls into question our results with these words, "if these claims are true," without having mentioned whether she even tested them.

Doubt must be cast on the reliability of certain investigations of Reed, who, without any consideration of the resting mycelium, induces infection by means of spores, under unnatural conditions, while we have shown clearly that the fungus, under practical conditions, brings about its effect indirectly only, by means of resting mycelium. So far as we know neither Reed nor Kolk has yet furnished proof that the testing of resistance by means of Reed's spore dusting method is irreproachable. As has been shown, resting mycelium occurs in oat seed in America also, and, if it were actually the case that there, in addition, the spores as such also remained viable between glume and kernel, to germinate into mycelia in the following spring, it would first be necessary to prove that the seedling infection caused by the spores runs parallel with that proceeding from the mycelium, and that the degree of susceptibility in the case of both types of infection would tend in the same direction. It is possible that this relationship exists, as Reed and Kolk assume; but yet, as has been mentioned, the proof has not yet been adduced.

The principal difference of opinion is in regard to the question whether it is correct to determine the effect of pickling substances on the spores or

on the resting mycelium. No one can doubt that the pickling of spores is pointless, because, as has been proved, it is not the spores that the pickling substance has to render harmless under practical conditions. A pickling substance can therefore be tested only on oat seeds containing mycelium. Spore pickling would, on condition that the seedling infection brought about by the spores parallels that caused by the mycelium, make it possible to recognize the effect of a pickling substance in case the spores would show exactly the same susceptibility to pickling as the resting mycelium. This, however, as we have abundantly proved, is not the case.

Attention may be called in this connection to still the following. Almost all of the viable spores germinate in the summer inside the oat flowers; therefore they scarcely have opportunity to overwinter in ungerminated condition. The few spores that remain undeveloped between the glume and kernel are, as has already been discussed above, in general the non-viable ones. There are still other proofs of the correctness of this conclusion, because it is significant that the spores are finely echinulate to facilitate attachment, that they are liberated at blossoming time; further, that the optimum for their germination is between 22 and 30°C. but that the optimum for the formation of mycelium lies between 18 and 26°C. Temperatures which prevail at blossoming time but not shortly after sowing, therefore are necessary for germination and mycelial formation. To attempt to consider the time consuming detour by a possible conidial formation as evidence against the presence of blossom infection, however, simply is not tenable, because, as Arland has shown, at a temperature approaching 30°C. absolutely no conidial formation occurs on the stigmas, clearly under the influence of the stigmatic secretion, but instead immediate mycelial formation occurs.

As has been said, natural conditions are not simulated if dehulled oat kernels dusted with spores are sown for the purpose of obtaining heavy attack and the seedling plants then treated in an unusual manner according to the proposal of Reed, because, practically, in the case of ordinary seed oats, hulled seeds and no naked seeds, with rare exceptions, are sown. In addition it has been shown by Haarring,[13] that the very laborious dehulling of the seeds in Reed's method can be supplanted by simple introduction of the spores by suction, using our evacuation method. Reed germinates the dehulled oat seeds, dusted with spores, at a relatively high temperature in a substrate provided with a very small amount of water. After the development of the first leaf, he transplants the seedlings into the open. He obtains by this artificial means an attack of 100 per cent in the case of susceptible varieties, even though, or, to use the words of Haarring, "because" he does not take into consideration the natural inter-

relations between host and parasite. With justice, Haarring says, "What is the value of so high an infection figure if it is only to be attained under abnormal conditions? There develops in the young oat plants, because of the high temperature for germination and growth, a soft, weakly tissue which can not interpose any resistance to the fungus on its way to the growing point." (p. 446.) "Certainly the oat varieties to be tested need not react at all similarly to such conditions, so entirely opposite to natural ones." (p. 446.) It is clear that this method can at any rate be useful for studies of resistance, insofar as the previously mentioned parallelism is proved, but nevertheless that it is entirely unsuitable for pickling tests. It already has been mentioned that pickling substances corresponding with the natural requirements of the fungus must be tested on the peripheral resting mycelium. Preparations which had only the ability to kill spores would be of very little value to us, entirely apart from the fact that one does not observe the so-called "deep effect" in the pickling of dehulled seed, which is exactly what is necessary in the case of loose smut of oats. The favorable pickling effect of formaldehyde is doubtless attributable to its very strong "deep effect".

All in all, too much artificiality is used in Reed's method, a procedure which is directly contrary to the natural developmental processes of plant and fungus. Hence it must appear strange when Kolk says in one place "intricate and unique methods of seed inoculation have been devised" by us for the attainment of infection, while it is exactly the method of Reed, which the authoress favors, that is everything but simple. It is worthy of reflection, further, that the authoress does not mention, and probably therefore does not even know, our simple evacuation method, published in the years 1928, 1929 and 1930. While there is required, according to the results of Haarring, 32 days, of eight hours' work daily, to infect one kg. of oats with Reed's method, there is required for the infection of the same amount of oats only 4 hours with the evacuation method. One therefore definitely reaches the conclusion, that the "intricate and unique method of seed inoculation" is indeed that of Reed.

That the seed treated by Reed's method produces plants with abnormal smut attack, is shown by our investigational results, which follow. While the seed inoculated by our method always showed the tendency in infection percentages, long known in practice, for the plants developing from the inner seeds always to show a heavier attack than those developed from the outer seeds, this difference did not appear in plants developed from seed inoculated by Reed's method. Plants arising from the outer seeds behaved, according to Reed, in the same way as those from the inner seeds. In some cases the plants developed from the inner seeds even showed

a weaker attack than those from the outer seeds. According to these experimental results, therefore, one should use inner seeds for seed. At least it would be immaterial, as far as loose smut attack is concerned, according to the results obtained by Reed's method, whether outer or inner seeds are used for seed. Actually, however, it is a known fact that outer seeds must be used for seed because, as mentioned, it is established that the plants derived from them are distinctly more resistant to loose smut than the inner seed plants.

Some of our figures may be used to support this. The results were obtained from a large number of plants, and are therefore well substantiated.

	INFECTION IN PER CENT	
	OUTER SEEDS	INNER SEEDS
Seeds dehulled, caryopses dusted with spores and sown directly in the open	16.67	16.18
Seeds dehulled, caryopses dusted with spores, the seedlings grown in boxes according to Reed's method and transplanted into the open.	66.67	40.63
Seeds inoculated by our evacuation method and sown in the open	51.35	66.20

If Kolk in another connection (p. 495) reports that von Rosenstiel[14] tried and compared different inoculation methods and was able to demonstrate that Reed's method was the most effective, it is to be said that in this publication the statement is indeed made that the method of Reed is marked by unconditional superiority. Kolk, however, omitted to subject to scrutiny the accompanying tables in which the actual results are given. Had she done this it would have struck her that the seed of Line 01108 inoculated with Reed's method produced an infection of only 29.6 per cent, and that of Dippes Ueberwinder one of 51.3 per cent. When, however, the seeds were inoculated by the Leipzig method and when moisture and temperature likewise were at the optimum at the stage of seedling infection, an infection of 100 per cent was attained in Line 01108 and 93.3 per cent in Dippes Ueberwinder. If seeds dehulled and dusted with spores according to Reed's method were sown directly in the open, the infection percentage was 0.0 in Line 01108, and in Dippes Ueberwinder 9.5 per cent. The seeds inoculated by the Leipzig method produced, on the other hand, 61.2 per cent infection in Line 01108, and 22.7 per cent in Dippes Ueberwinder. On careful examination of the tables it strikes one, further, that the reputed uniformity in the results obtained by von Rosenstiel by Reed's method also is not present. In this respect, also, the opposite is true. Some figures from von Rosenstiel's work will show this.

[14] Phytopath. Zeits. 1: 317–360, 1930.

If, therefore, the tables are correctly interpreted, one reaches exactly the opposite conclusion to that of von Rosenstiel.

That the mycelium in the glume parenchyma plays a more important role in the subsequent seedling infection, under our ecological conditions, than that present on the outer layers of the caryopsis, appears, moreover, from experiments which we made with seed inoculated by the new evacuation method. After the spores had been introduced by suction and the formation of resting mycelium had been induced, a part of the seed was sown without further treatment. Another part of the seed was handled in this manner: smut-free caryopses, that is, kernels which had been taken

SEEDS INOCULATED BY THE LEIPZIG METHOD AND THE SEEDLINGS GROWN UNDER OPTIMUM TEMPERATURE AND MOISTURE CONDITIONS		SEEDS INOCULATED BY REED'S METHOD AND THE SEEDLINGS ALSO GROWN UNDER OPTIMUM TEMPERATURE AND MOISTURE CONDITIONS	
DIPPES UEBERWINDER	LINE 01108	DIPPES UEBERWINDER	LINE 01108
Percentages of infection			
95.7	100.0	45.6	5.5
96.7	100.0	73.7	21.6
88.6	100.0	34.6	61.9

from healthy oat seeds, were introduced between infected glumes that contained mycelium. A third lot of seeds was compounded of mycelium-free, therefore uninfected, glumes and diseased kernels which had mycelium in the pericarp. The most important thing in this connection was that the kernels should fit perfectly between the glumes in every case. For this reason provision was made for the careful sealing of the seeds[15] by dipping the tips of the glumes in gum arabic. When the work was carefully done, one attained a normal growth of the plants and an irrefutable answer to the question regarding the location of the principally effective infection center. The investigations showed that by far the heaviest attack occurred when the glumes and kernel were provided with mycelium, that the attack was weaker when only the glumes contained mycelium, and weakest when only the caryopses contained it. On sowing dehulled seeds infected with mycelium, we obtained scarcely one-third the severity of attack as with hulled seeds infected with mycelium. From this it is certain that the glume mycelium represents the principal infection center under our conditions.

For the elucidation of the question as to what the situation is in hull-less oats, Rösch dusted several hundred flowers of *Avena nuda* with smut spores. Microscopic examination showed that almost all the spores germinated just as in the case of hulled oats. Rösch, however, calls attention in this connection to still another kind of infection, which may have a certain significance, especially in the case of hull-less oats. He writes: "In general, most of the smut spores are liberated at the time the oats are harvested.

[15] Spelzfrüchte in original.

Often, however, the smutted panicles of individual belated culms, because of too late development, remain in the leaf sheaths. On threshing, then, these culms are broken up, the spores fly about in the threshing machine, and can attach themselves to the naked oat seeds." (p. 385.) Since, according to the previously mentioned demonstration of Sampson, only the completely mature spores, that is, those collected in July, a considerable time after blossoming, retain their viability for years, it is by all means necessary to reckon with this mode of infection in the case of hull-less oats. That this, however, is of very slight significance in the case of hulled oats, as hulled oat seeds dusted externally with spores produce virtually no infected plants, is sufficiently well known. The explanation for this is given by Zade[3]: "The seedling develops directly from the dehulled seed and, as soon as it has broken through the seed coats, the infection, that is, the penetration of the fungus mycelium into the plumule of the leaf, can proceed immediately. This process is different in the case of seed enveloped in the glumes. In this case the seedling can be infected only after it has pushed out through the glumes, that is, when it has traversed approximately 1 cm. longitudinally between glume and kernel, because normally the plumule of oats grows within the glume envelope up to the glume tip, there first to reach the outside. An oat seed, therefore, can be considered to have germinated, in contrast to rye and wheat, only when the plumule becomes visible, not as soon as it has broken through the pericarp of the caryopsis. An infection by means of the spores possibly adhering to the outside of the glume envelopes would therefore be possible only after the time when the plumule has left the tips of the glumes, and in this stage of growth it is no longer so tender and so susceptible as at the time of the breaking forth from the envelope of the kernel. In nature several days usually elapse, at low temperature under certain conditions weeks after sowing, before the plumule which has proceeded from the caryopsis leaves the glume tips behind and is accessible to infection by the smut fungus. Furthermore, it is to be noted that the spores on the outside of the hulled seed, insofar as they do not happen to be on the tip, are scarcely able to produce fungus threads long enough to reach and attack the seedling. In other words, the spores which may germinate can reach their goal only in rare cases." (p. 399.)

The view of Kolk that the presence of mycelium in the glumes is not to be considered "an actual invasion of the host" is not correct. It is far more a case of actual infection, because the mycelium penetrates into the fresh green plant tissue and ramifies it. It is not comprehensible why the presence of mycelium in the growing point of the embryo or in other parts except the protecting glumes is necessary, for justification of the concept

of infection. The infected floral envelope belongs to the flower just as much as does the embryo.

That *Ustilago Avenae*, after previous blossom infection, penetrates into the host plant by means of seedling infection, Zade and his students have never doubted, but rather always supported. In particular the penetration of the fungus into the young oat seedling, that is, seedling infection, is described accurately on the basis of detailed investigations and, in addition, illustrated by figures in the works of Rösch[6] and Haarring.[13] Naturally, seedling infection is not only present when the mycelial threads growing from the recently germinated spores penetrate the seedling, but also when the infection proceeds from the peripheral resting mycelium.

To go into detail with respect to further points in the work of Kolk would probably be superfluous in this connection. We reserve an amplification of our reply for another place.

The production of vestigial and sterile sex-organs through sex-reversal and neutral sexual states[1]

JOHN H. SCHAFFNER

(WITH PLATE 8)

The vascular plants fall naturally into two fundamental groups in respect to the sexual condition of their sporophytes. In the lower level, the sporophytes are normally entirely neutral showing no sex dimorphism at any stage of their life, while in the higher level, the sporophytes always develop sexual states and show sex dimorphism before the completion of their ontogeny. In any consideration of the sexual conditions of the vascular plants, the recognition of the nature of the evolution of the time of sex determination in the life cycle becomes of paramount importance. Apparently the bisexual state is present in all sporophyte individuals of the living heterosporous pteridophytes and is plainly also the original condition for all angiosperms, the monoecious or dioecious conditions being secondary in the evolutionary sequence. In the fossil gymnosperms there are examples of the bisporangiate or bisexual condition and in a few living species the presence of vestigial structures of the opposite set of sporophylls in the flowers indicates an original bisporangiate condition. In the living cycads and conifers, however, no vestigial structures of the opposite sporophylls appear, and we can assume, as a reasonable hypothesis, that these plants had monoecious branches before flowers had evolved, namely before a determinate condition of the reproductive branch was attained. Thus there would be no functional gradients developed in a given determinate branch which might cause the production of both male and female states and thus bring into play hereditary factors for male and female characters. From the monoecious condition, either directly or through a series of degrees of monoeciousness, the final dioecious condition then evolved in various gymnosperm lines and apparently, since the original individual flowers were never dimorphic in respect to sex, the dioecious species also never show vestiges of the opposite sex organs.

In the angiosperms, however, the primitive, or original condition of the flower is bisexual and from this condition monoeciousness in all degrees of promptness of development and degrees of intensity and also dioeciousness in various degrees of intensity of the one or the other sexual state of the individual evolved. The nature of the sexual phenomena exhibited by the taxonomic system of the angiosperms indicates plainly that sexuality is a fundamental potentiality and that the various sexual states and con-

[1] Papers from the department of botany, The Ohio State University, No. *309*. Read at the Sixth International Congress of Genetics, Ithaca, New York.

ditions, ranging from normal femaleness through neutrality to normal maleness, result from physiological conditions or gradients in individual cells or cell lineages. These implications are fully confirmed by experimental results, which up to the present time have been occupied largely with the production of sex-reversal and control in both monoecious and dioecious plants. Little if anything at all has been done in attempted control of sexual expression in bisporangiate flowers, although one occasionally sees complete transformation of one set of sporophylls to the other in such bisporangiate flowers.

In the original flower type of the angiosperms, the floral axis passes from a neutral state to the secondary male state and then by a prompt reversal to the secondary female state. In various primitive types of such flowers, however, the reversal of the growing flower bud from the male to the female condition is rather slow so that a considerable neutral development takes place in the transition which may manifest itself in several ways. Thus in species of *Michelia*, *Geum*, *Nelumbo*, etc. there is a prominent development of an internode separating the stamens below from the carpels above. In *Michelia* the internodal development between the androecium and gynoecium is sometimes as much as a centimeter or even more. This neutral condition is also indicated by the long stipitate condition of the gynoecium found in the flowers of various species of *Baptisia*, *Meibomia*, *Subularia*, *Lunaria*, *Cleome*, *Cristatella*, etc.

In *Aquilegia canadensis* L. and other species the neutral zone between the stamens and carpels develops a number of distinctive bracts which are typical neutral organs unlike either the stamens or carpels. Another rather primitive type of flower which shows prominent neutral structures between the gynoecium and androecium is *Calycanthus floridus* L. The entire receptacle is expanded into a cup and the neutral transition ring of tissue between the central carpellate region and the outer staminate rim is occupied by prominent, short, sterile bracts which are on the one hand much like stamens but without microsporangia and on the other like imperfect carpels. The neutral transition thus bears carpellodes next to the normal carpels and staminodes next to the normal stamens while the central part contains bracts intermediate in nature. The staminodes next to the normal stamens sometimes bear minute, imperfect microsporangia. In general, the decided determinateness of the floral axis of the higher types of flowers should not permit of such intermediate structures and apparently neither internodes nor neutral bracts appear on the transition zone of the higher bisporangiate flower types, because in these the general determination of the system develops much more rapidly than in the lower.

The evolution of monoeciousness from the bisporangiate flower con-

dition is accomplished in various ways, the most interesting for the present discussion being the type in which the inflorescence axis produces first carpellate flowers and later, through sex-reversal staminate flowers or with a progression from the neutral vegetative condition in the opposite sequence, first staminate flowers and then carpellate. The evolution of this type of monoeciousness often appears to be in an orthogenetic sequence, producing an orthogenetic series of inflorescences. In the Alismataceae, *Echinodorus cordifolius* (L.) Griseb. has bisporangiate flowers, *Lophotocarpus calycinus* (Engelm.) Sm. has bisporangiate flowers below and staminate flowers above, while the typically monoecious *Sagittaria latifolia* Willd. has carpellate flowers below and staminate ones above. *Sagittaria* is a primitive type of monocotyl and the flowers are in general in a very primitive condition. Thus when the sex-reversal from femaleness to maleness takes place in the inflorescence axis, a neutral transition zone is necessarily produced and since it is entirely due to developing physiological gradients it frequently happens just at the level where incipient flower buds are developing. Thus these buds begin their growth as neutral systems just as they do in *Echinodorus* or as the flowers of *Sagittaria* did before monoeciousness had evolved. The result is frequently the development of one or more bisporangiate flowers on the transition zone.

The same evolutionary sequence is shown in the lower aroids and other groups. *Acorus Calamus* L., for example, has its spadix covered with bisporangiate flowers; in *Orontium aquaticum* L. there are often a few staminate flowers at the very tip, the rest being bisporangiate; in *Calla palustris* L. the flowers of the upper part of the spadix are staminate; while in species like *Zantedeschia aethiopica* (L.) Spring. and *Peltandra virginica* (L.) Kunth. the normal monoecious condition has been attained, the flowers at the lower end of the spadix being carpellate and those above being staminate. In some of the higher types of aroids, like species of *Helicodiceros* and *Helicophyllum*, which have more complex hereditary systems, the neutral transition zone of the inflorescence axis develops peculiar and characteristic structures, internodes, and outgrowths which are neither stamens nor carpels. The reactions correspond to those that occur in the flowers of *Michelia* and *Aquilegia*.

Zizania aquatica L. and *Ricinus communis* L. are examples of monoecious inflorescences which have the staminate flowers below and the carpellate ones above, and in both cases, as in *Sagittaria latifolia*, bisporangiate flowers are commonly produced on the neutral transition zone, especially in *Zizania*.

In the monoecious *Typha latifolia* L., the carpellate flowers are below and the staminate above. Since the two halves or even small segments of

the inflorescence bud may be in different physiological states, a chimera-like effect is often produced in the distribution of areas or bands of carpellate and staminate tissues. On the transition line between the two conditions there may be a neutral zone of greater or less extent, and since the spiral position of the flowers on the inflorescence is not at all dependent on any special sexual state, but is determined by the fundamental hereditary potentialities, the flowers are often situated exactly on the middle or on the sides of these neutral bands of tissue. The result is that frequently these flowers are decided sex mosaics. Sometimes a stigma may be nearly normal on the one side and develop a microsporangium on the other. Another extreme condition which is sometimes produced is the development of pollen-grains inside of the stigma.

Arisaema triphyllum (L.) Torr. is a peculiar type of dioecious plant in that its sexual condition is dependent very largely on its environment. Its functional states are, therefore, easily controlled in such a way that the inflorescence is thrown into a sex mosaic with spots or bands of male and female tissue. Thus, as in *Typha*, a zone of neutral tissue may develop where the two tissues of opposite sexual states come together, although the male and female areas may also be closely contiguous. In the first case, neutral, horn-like structures may develop where otherwise there would be a normal staminate or carpellate flower. If there is no intervening neutral zone of any appreciable width, then the flowers which appear on the transition line will themselves be sex mosaics, sometimes having one or more pollen-sacs on the side of the ovulary toward the male tissue, or even having a stigmatic structure only on the side toward the female tissue and one or more pollen-sacs on the side toward the male tissue.

Bisporangiate flowers or flowers representing extreme sex-mosaics have also been observed to occur regularly on abnormal, monoecious *Salix amygdaloides* Anders. These willows were evidently mutants from the normal dioecious form. They regularly produce catkins which have normal staminate flowers below and normal carpellate flowers above. The transition zone is quite broad indicating a slow reversal of the catkin axis from male to female during its ontogeny. Some of the sex mosaics were observed to have microsporangia imbedded in the walls of the ovulary, others approached more nearly the bisporangiate flower type, while some were normal bisporangiate flowers. These willow trees have existed for many years on a farm in Kansas and their sex reactions are in complete agreement with what takes place in similar, normal, monoecious types or with the reactions following experimental sex reversals in both monoecious and dioecious species.

One of the very striking phenomena to be observed in the angiosperms

is the presence and distribution of vestiges of the opposite type of sex organs in the monosporangiate flowers of both monoecious and dioecious species. All monosporangiate angiospermous flowers have plainly come from bisporangiate ancestral species, as stated above, through the progressive evolution of the time of sex determination in the sporophyte. This progression is a backward movement through the ontogeny and reaches its determinate limit when the sexual state is determined in the fertilized egg itself, resulting in a dioecious condition, where the individuals of both the gametophyte and sporophyte are normally unisexual. The development of the male or female state in a tissue or individual varies both in intensity and promptness and these conditions determine the presence or absence of vestigial organs or their degree of perfection in comparison with the normal sporpohyll condition. The character and distribution is in general the same in monoecious and dioecious flowers. Cases in which vestiges are present in one flower and not in the other, whether in monoecious or dioecious species are to be regarded as sexual dimorphisms or sex-limited characters the same as dimorphisms in the vegetative parts.

There are four general types of distribution of the vestigial sporophylls in monosporangiate flowers: 1, both carpellate and staminate flowers with vestiges of the opposite sporophylls; 2, carpellate flowers with vestiges, staminate flowers without vestiges; 3, carpellate flowers without vestiges, staminate flowers with vestiges; 4, both carpellate and staminate flowers without vestiges. Below are given examples of monoecious and dioecious species for each type.

1. Both carpellate and staminate flowers with vestiges. MONOECIOUS: *Rumex altissimus* Wood, *Cucumis sativus* L., *Silphium integrifolium* Mx., *Musa sapientum* L., *Eriocaulon compressus* Lam., *Cocos nucifera* L., *Zizania aquatica* L., *Tripsacum dactyloides* L., *Coix Lachryma-Jobi* L. DIOECIOUS: *Phoenix dactylifera* L., *Asparagus officinalis* L., *Bulbilis dactyloides* (Nutt.) Raf., *Chamaelirium luteum* (L.) Gr., *Aruncus Aruncus* (L.) Karst., *Sassafras Sassafras* (L.) Karst., *Ailanthus glandulosa* Desf., *Diospyros virginiana* L., *Gymnocladus dioica* (L.) Koch, *Acer platanoides* L., *Lychnis alba* Mill.

2. Carpellate flowers with vestiges, staminate flowers without vestiges. MONOECIOUS: *Zantedeschia aethiopica* (L.) Spreng., *Peltandra virginica* (L.) Kunth, *Zea Mays* L. (some varieties). DIOECIOUS: *Menispermum canadense* L., *Napaea dioica* L., *Smilax hispida* Muhl., *Vallisneria spiralis* L.

3. Carpellate flowers without vestiges, staminate flowers with vestiges. MONOECIOUS: *Buxus sempervirens* L., *Ambrosia trifida* L., *Amaranthus*

retroflexus L., *Quercus alba* L. DIOECIOUS: *Phoradendron flavescens* (Pursh) Nutt., *Antennaria plantaginifolia* (L.) Rich., *Carica Papaya* L., *Rumex Acetosella* L., *Morus rubra* L.

4. Both carpellate and staminate flowers without vestiges. MONOECIOUS: *Ricinus communis* L., *Alnus Alnus* (L.) Britt., *Hicoria ovata* (Mill.) Britt., *Sicyos angulata* L., *Typha latifolia* L., *Sparganium eurycarpum* Engelm., *Alocasia odora* C. Koch, *Naias flexilis* (Willd.) R. & S., *Zannichellia palustris* L. DIOECIOUS: *Populus deltoides* Marsh., *Salix purpurea* L., *Fraxinus americana* L., *Acer Negundo* L., *Cannabis sativa* L., *Arisaema triphyllum* (L.) Torr., *Humulus japonicus* Sieb. & Zucc., *Thalictrum dioicum* L.

The true nature of sexuality and the vestigial structures which appear in monosporangiate and reversed flowers having been indicated by the taxonomic series and by direct experiment, a practical application could be made in the production of neutral, vestigial sporophylls. Indian corn (*Zea Mays* L.), which is a monoecious plant of the extreme type, just one step from the dioecious condition, in which the lower part of the main stem is neutral, the middle branches female, and the top of the main stem male in normal sex expression, seemed a very favorable species to demonstrate experimental control of the neutral state, since there is a definite gradient of physiological states in the ontogenetic development from the juvenile to the mature condition. The main stem continues in the neutral state until the reproductive phase is approached when the physiological gradient develops toward maleness. The secondary male state is finally established and when the inflorescence is developed, it is purely male in character expression, no external vestige of the gynoecium appearing in the flowers. This shows that at the time of flower development the secondary male state is fully and intensely established. In most varieties, the lateral female inflorescence shows minute vestiges of stamens around the ovulary. This indicates that the secondary female state was not developed to the extreme degree at the time when the sporophylls began to be determined. Both the side branches with their ears and the terminal stalk with its tassel are definitely determinate systems under ordinary environmental conditions of growth, the reproductive reaction initiating determinateness or stopping of growth and bringing on death at the end of the differentiation process.

Since the terminal bud can easily be thrown over to femaleness during its growth, even at an early period by a properly controlled environment, in which a short daylight period is a very essential factor, it follows that the terminal bud of the main stem can be brought to the neutral point just at the time when the reproductive process is beginning to take place. But

the reproductive process in the flower requires the presence of the secondary male state or physiological activity in order to bring about stamen development, or the secondary female state or female physiological activity in order to bring about carpel development. In the normal gradient toward the tassel, maleness has been attained at this point and normal staminate flowers develop. If the system has been somewhat lowered in physiological activity the tassel may develop as a sex mosaic and produce carpellate and bisporangiate flowers as well as staminate ones. Or if the system has been lowered so that the bud is in the secondary female state at the beginning of flower production, normal carpellate flowers only will be expressed as in the lateral inflorescence. Now if the bud is at the zero point in relation to the sex balance nothing can be in activity, since there is neither a secondary female state nor a secondary male state in the cells there can be no secondary sex factors thrown into activity and so there are no staminate nor carpellate flowers produced. On the other hand, the terminal bud can not continue vegetative growth because of the development of extreme determinateness in the entire system. Thus the whole tassel is matured as a minute vestige, often not more than one or two centimeters long on a very slender peduncle. This vestige is the neuter expression of the sexual reproductive organs of the Indian corn. Although the experimental method depends on a very accurately timed physiological balance in relation to maturity, from 20–40 per cent of neutral tassels can easily be produced in a given population.

Since the floral development in Indian corn begins somewhere near the middle of the inflorescence and proceeds from there toward the base and apex at the same time, it follows that if the system has advanced toward the female condition so that the reversal will take place before the first flowers are determined, then the floral development will proceed with the secondary female state to the base of the inflorescence axis, and a fair-sized ear or female inflorescence will result. But the outer end of the inflorescence axis will have only a neuter vestigial tip since the determinate ontogenetic gradient will prevent a progression to the female state or to a renewed vegetative growth. The little terminal ear always has a sterile or neutral tip just as is usually the case in a side inflorescence or normal lateral ear.

If the ecological conditions are so controlled that the physiological state has not attained to femaleness when the first central flowers of the inflorescence develop but is nevertheless soon to pass over to that condition, then the secondary male state may be developed at this point and a zone of staminate flowers will be produced which will soon pass over to the neutral condition both above and below. If now the ecological factors have

been so controlled by increasing the length of daily illumination at the proper time in the ontogeny there will promptly be developed a greater physiological vigor and this will delay the determination at the tip of the axis enough to allow a female state to arise, then the axis of the inflorescence will, after passing through the upper and lower neutral conditions produce female structures at the outer end as well as at the lower. The inflorescence which results will then consist of five definite zones, namely a central zone of staminate spikelets and flowers with a neutral transition zone of vestigial spikelets on each side of this with female expression resulting in little ears at the two extremes (plate 8). Thus instead of the usual branched staminate tassel we have the remarkable result of a sex mosaic consisting of five zones, (1) a basal female zone with normal fruit development, (2) a neutral vestigial zone, (3) a zone of normal staminate flowers, (4) a second neutral zone, followed by (5) a second female zone with normal fruit development at the outer tip. On account of the complexity of the physiological gradients one can only occasionally produce this result, although it is not difficult to bring out female expression at the ends of the main axis or branches of the inflorescence. These expression phenomena are all clearly consistent with what we know of the ontogenetic and physiological gradients and are consistently interpreted by the physiological theory of sexuality. Any attempt to seek an explanation of sexuality and sex in terms of a balance of genes instead of a balance of physiological states would be beside the mark, since in all of these processes the balance of genes apparently remains exactly the same. The ordinary vegetative karyokineses are continuing the original diploid complement of chromosomes and balance of genes just as definitely as we know they do when varieties of fruit are propagated indefinitely by means of grafting and stem cuttings.

A multitude of such phenomena which confront the taxonomist shows that the genetic hypotheses of sex and sex-determination are entirely untenable and have no correspondence with the actual conditions in which sex is manifested in the plant kingdom.

An investigation of the nature and causes of neutral states, sterility and imperfect sex expressions must lead to developments of far-reaching importance both in general biology and in the biology of human sex conditions. The bees and various other insects have evolved hereditary constitutions through which they instinctively produce males, females and partial neuters at will. Through the reactions of the workers in producing cells of the proper size and the subsequent feeding of the larvae on the one hand and on the other probably through the instinctive nervous reactions of the queen, the sexes of the normal colony are very decidedly controlled.

Partial neuter conditions and partial sex-reversals are common in humans and it is of the greatest importance to the wellfare of society that the exact causes of neutrality, sex-reversal, and sterility of both males and females be discovered and proper treatments be developed to overcome barrenness and undesirable neutral and reversed mental reactions. It frequently happens that those who have the highest mental endowment and otherwise a normal physical condition cannot perpetuate their desirable hereditary lines. The proper study of neutrality in plants may prove as enlightening for the problem of human sterility as the mendelian study of plant heredity proved to be for the problem of animal heredity.

COLUMBUS, OHIO.

SCHAFFNER: SEX IN INDIAN CORN

UNIV. OF MICH.

Studies of South American Plants. III.

New Ericaceae and Vacciniaceae

ALBERT C. SMITH

In the accompanying paper specimens from several large herbaria are cited. These institutions are indicated by the following abbreviations: Botanisches Museum, Berlin-Dahlem (B); British Museum (BM); Herbier Boissier, University of Geneva (Bo); Conservatoire Botanique, Geneva (C); Royal Botanic Gardens, Kew (K); U. S. National Museum (N); Museum d'Histoire Naturelle, Paris (P); New York Botanical Garden (Y).

ERICACEAE

Gaultheria Tatei sp. nov. Frutex parvus compactus; ramulis subteretibus fuscis, juventute puberulis ac etiam parce glanduloso-setosis, mox glabrescentibus; petiolis subrugosis nigrescentibus decidue setosis 2–3 mm. longis; laminis coriaceis ovato-oblongis, 2–3 cm. longis, 1–1.5 cm. latis, basi rotundatis vel obtusis, apice subacutis et nigro-calloso-mucronatis, margine leviter incrassatis et crenulato-serratis (dentibus 10–15 per centimetrum), utrinque subglabris (juventute parce setosis) et nigro-punctatis, pinnatinerviis, costa supra leviter impressa subtus prominente, nervis secundariis 3- vel 4-jugis brevibus arcuato-adscendentibus, supra subplanis subtus elevatis, venulis subtus conspicue reticulatis; inflorescentia copiosa prope apices ramulorum axillari, racemosa 8–12-flora; rhachide 2–3 cm. longa velut ramulis juvenilibus puberula et glanduloso-setosa, basi bracteata; pedicellis gracilibus velut rhachide pubescentibus 7–9 mm. longis, bracteis coriaceis lanceolato-obovatis 4–5 mm. longis subtentis (bracteis margine puberulis et glanduloso-ciliatis), bracteolis minoribus prope basin bibracteolatis; florum partibus exterioribus ubique parce albo-puberulis ac etiam parce glanduloso-setosis (pilis 0.5 mm. longis); calycis lobis elongato-deltoideis sub anthesi circiter 4 mm. longis et 2 mm. latis; corolla tenuiter carnosa cylindrico-urceolata, maturitate 6–7 mm. longa et 3–4 mm. diametro, lobis 5 oblongis obtusis circiter 1.5 mm. longis; staminibus 10, 4–4.7 mm. longis; filamentis stramineis ligulatis gracilibus 3.5–3.8 mm. longis, pilos delicatulos ad 0.5 mm. longos gerentibus; antheris aristis brevibus inclusis circiter 1.5 mm. longis; ovario depresso-globoso sub anthesi circiter 2 mm. diametro albo-puberulo; stylo carnoso 3–3.5 mm. longo, stigmate truncato.

Type, *G. H. H. Tate 217*, collected in 1925 on sub-páramo on Cerro de Turumiquire, State of Sucre, Venezuela, alt. 3000 meters, and deposited in the U. S. National Herbarium (no. 1,230,901). It is a species allied to *G. reticulata* H.B.K., which it resembles very closely in foliage, but from which it differs by having the venation less obvious on the upper leaf surface. In floral aspect, the new species has the calyces and corollas pubescent

rather than glabrous, the calyx lobes more acuminate, and the bractlets of the pedicels longer.

Gaultheria megalodonta sp. nov. Frutex; ramulis elongatis (dependentibus?) subteretibus nigrescentibus glabris; petiolis subrugosis glabris 1–2 mm. longis; laminis coriaceis glabris supra nitidis late ovatis vel suborbicularibus, 15–20 mm. longis et latis, basi truncatis vel subcordatis, apice calloso-apiculatis, margine valde serratis (dentibus 6 vel 7 per centimetrum), pinnatinerviis, nervis secundariis 2- vel 3-jugis, e costa prope basin orientibus, arcuato-adscendentibus, cum costa utrinque elevatis, venulis paucis reticulatis utrinque elevatis; inflorescentia axillari apices ramulorum versus congesta, racemosa, quam foliis duplo vel triplo longiore, 12–20-flora; rhachide subtereti recta 3–5 cm. longa, minute pallide puberula ac etiam pilis ferrugineis circiter 1 mm. longis setosa; pedicellis gracilibus 4–8 mm. longis, velut rhachide pubescentibus, bracteis deciduis coriaceis parce fimbriatis oblongis 5–7 mm. longis subtentis, prope basin bibracteolatis, bracteolis oblongo-subspatulatis circiter 3 mm. longis fimbriatis; florum partibus exterioribus juventute ubique minute pallide puberulis, mox glabrescentibus, 5 (raro 6)-meris; calycis lobis deltoideo-ovatis acutis sub anthesi circiter 3 mm. longis et 1.5 mm. latis; corolla cylindrico-campanulata, maturitate 6–7 mm. longa et 3–4 mm. diametro, lobis deltoideis obtusis circiter 1 mm. longis et latis; staminibus circiter 3.5 mm. longis; filamentis pallide castaneis subglabris, 2.5–3 mm. longis, prope basin circiter 0.5 mm. latis, superne contractis; antheris leviter granulatis, aristis brevibus inclusis 1–1.3 mm. longis, per poros ovales subapicales dehiscentibus; ovario subgloboso, sub anthesi circiter 2 mm. diametro, minute molliter piloso; stylo 3–3.5 mm. longo, stigmate subcapitato.

Type, *Pearce*, collected in Ecuador, alt. about 3700 meters, and deposited in the herbarium of the Royal Botanic Gardens, Kew. It is a very distinctive species by virtue of its densely aggregated racemes and its suborbicular coarsely serrate leaves. Probably it is related to *G. reticulata* HBK., from which it differs by having the leaves proportionately broader, often subcordate at base, more obviously serrate, the venation less closely reticulate, and the pubescence of rachis and pedicels more pronounced.

GAULTHERIA INSIPIDA Benth. and its allies: *G. insipida* Benth. and four allied species form a very natural group in the northern Andes. The species are characterized by the straight subappressed strigose hairs of the branchlets and by the bullate leaves with conspicuous secondary veins. The five species may be distinguished among themselves thus:

Calyx glabrous.
  Leaves not arachnoid-lanate.
    Leaves rounded at base, long-setose at margin; calyx lobes acuminate *G. insipida*
    Leaves subacute at base, short-setose at margin; calyx lobes acute. . . *G. tolimensis*
  Leaves arachnoid-lanate beneath. . . . . *G. arachnoidea*
Calyx densely strigose.

Leaves nearly plane or slightly recurved at margin, more than 10 mm. broad .... *G. strigosa*
Leaves tightly revolute at margin, 5–8 mm. broad..... *G. revoluta*

GAULTHERIA INSIPIDA Benth. Pl. Hartw. 225. 1846. *Gaultheria petraea* Wedd. Chlor. And. **2:** 174. 1860. The two type specimens here concerned show no essential differences, the species being very consistent throughout its range. It grows at altitudes from 2400–3600 meters, and is represented by:

COLOMBIA: Minas, *Lehmann B. T. 1059* (Y). Tolima: Mt. Tolima, *Tracey 232* (K). Quindio Region, *Dawe 734* (K, Y). El Valle: Alto San Antonio, near Cali, *André 2644* (K). El Cauca: San Antonio, *Pennell & Killip 7297* (K, Y), *7298* (Y), *7431* (Y), *Pennell 7567* (Y). Cuatro Esquinas, *Pennell & Killip 6331* (Y). Río Palace, near Popayan, *Lehmann B. T. 640* (K, Y). Río Micay, *Lehmann B. T. 641* (C). Nariño: Pasto, *Triana 2642* (B, C, K). Páramo de Guapuscal, near Pasto, *André 3144* (K, Y).

ECUADOR: *Hall 3* (K), *4* (K). *Sodiro 93/3* (B). Pichincha: *Jameson* (K), *29* (Y), *75* (BM, C, P, type of *G. petraea*[1]). Between Quito and Machachi, *Hartweg 1229* (C, K, type). Mt. Pichincha, *Jameson 17* (K), *276* (K), *309* (BM, C, K). Between Malchinguí and Pomasqui, *Hitchcock 20878* (Y). Tunguragua: Mt. Tunguragua, *Spruce 5107* (BM, C, K). Azuay: Cuenca, *Warszewicz* (B).

GAULTHERIA TOLIMENSIS Wedd. Chlor. And. **2:** 173. 1860. The differences between this species and the preceding are not strongly marked. It is found at elevations of 3400–3900 meters, and is represented by:

COLOMBIA: Tolima: *Goudot 2* (K, P). Mt. Tolima, *Linden 919* (C, P, type). Cerro de perro, near Ibague, *Goudot 1* (P). Quindio region, *Linden 1119* (C, P). Caldas: Cerro Tatama, *Pennell 10569* (Y).

Gaultheria arachnoidea sp. nov. Frutex compactus; ramulis teretibus brevibus, juventute pilis crassis ferrugineis 1.5–2 mm. longis dense strigosis ac etiam parce albo-arachnoideo-lanatis, demum glabrescentibus; petiolis circiter 2 mm. longis velut ramulis pubescentibus; laminis coriaceis ovato-oblongis, 18–30 mm. longis, 7–11 mm. latis, basi acutis, apice breviter acuminatis, margine subintegris et valde revolutis, supra ferrugineo-strigosis mox glabrescentibus, subtus pilis 1.5–2 mm. longis persistenter strigosis ac etiam pilis minutis laxis dense et arcte albo-arachnoideo-lanatis, pinnatinerviis, costa supra impressa subtus prominentissima, nervis secundariis 3- vel 4-jugis patulis, supra planis, subtus elevatis indumento saepe occultis, venulis reticulatis; inflorescentia axillari breviter racemosa 5–9-flora; rhachide gracili 7–12 mm. longa, pilis ferrugineis patulis ad 1 mm. longis dense pilosa; pedicellis gracilibus 3–5 mm. longis, pilos circiter 0.5 mm. longos gerentibus, bracteis ovatis subglabris breviter fimbriatis circiter 3 mm. longis subtentis, prope basin bibracteolatis, bracteolis 2 mm. longis; calyce subcoriaceo glabro, lobis 5 deltoideis acutis, sub anthesi circiter 2.5 mm. longis et 2 mm. latis; corolla

[1] Although the type of *G. petraea* is cited as *Jameson 196*, that number is not found at Paris. *Jameson 75* bears notes which indicate that Weddell's species was based upon it.

tenuiter carnosa glabra ovoidea, maturitate circiter 5 mm. longa et 4 mm. diametro, superne contracta, lobis 5 oblongis obtusis circiter 1 mm. longis et latis; staminibus 10 circiter 3.5 mm. longis; filamentis ligulatis stramineis parce puberulis circiter 2.5 mm. longis; antheris oblongis, aristis brevibus inclusis 1.3–1.5 mm. longis, per poros subapicales dehiscentibus; ovario subgloboso sub anthesi circiter 2 mm. diametro, minute molliter piloso; stylo crasso circiter 3 mm. longo, stigmate subcapitato.

Type, *Jameson 499*, collected on Volcano of Pasto, Department of Nariño, Colombia, alt. about 3700 meters, and deposited in the herbarium of the Royal Botanic Gardens, Kew. Duplicates at BM, C, Y. It is a species which differs from its allies *G. insipida* Benth. and *G. tolimensis* Wedd. by the unique pale arachnoid indumentum of young branchlets and lower leaf surfaces, and also by having the leaves smaller and more closely revolute.

GAULTHERIA STRIGOSA Benth. Pl. Hartw. 221. 1846.

COLOMBIA: *Bonpland* (P). *Lehmann B. T. 1059* (K). Cundinamarca: Páramo de San Fortunato, near Bogotá, *Hartweg 1211* (B, BM, C, K, type, P). Between Sibaté and San Fortunato, *Triana 2640* (P). Near Sibaté, *Linden 813* (BM, C, P). Fusagasuga, *Triana 4323/5* (B). Tolima: Quindio region, *Goudot* (P). Antioquia: Alto San José, *Kalbreyer 1883* (B, K). Caldas: Cerro Tatama, *Pennell 10523* (Y).

Gaultheria revoluta sp. nov. Frutex parvus compactus; ramulis subteretibus rectis rigidis, juventute pilis ferrugineis aristatis 1–1.5 mm. longis dense strigosis, demum glabrescentibus et cinereis; petiolis subrugosis subteretibus decidue strigosis circiter 2 mm. longis; laminis coriaceis ovato-oblongis, 15–23 mm. longis, 5–8 mm. latis, basi ac apice acutis, margine integris vel minute crenulatis et valde revolutis, utrinque pilis deciduis 1 mm. longis ferrugineis strigosis (pilis subtus costa persistentibus), pinnatinerviis, costa supra impressa subtus prominentissima, nervis secundariis 3-vel 4-jugis brevibus patulis supra planis subtus prominentibus, venulis reticulatis; inflorescentia prope apices ramulorum axillari breviter racemosa 3–7-flora; rhachide gracili 5–12 mm. longa parce strigosa basi bracteata; pedicellis gracilibus 3–6 mm. longis dense ferrugineo-strigosis, bracteis ovatis glabris circiter 2.5 mm. longis et 2 mm. latis subtentis, prope basin bracteolis similibus minoribus bibracteolatis; calyce campanulato, pilis ferrugineis 1 mm. longis dense strigoso, distaliter glabrescente, lobis 5 deltoideis acutis, sub anthesi circiter 3 mm. longis et 2 mm. latis; corolla breviter cylindrica, maturitate 5–6 mm. longa et 3–4 mm. diametro, superne contracta, velut calyce strigosa, lobis 5 deltoideis subacutis circiter 1 mm. longis et latis; staminibus 10, 3.5 mm. longis; filamentis stramineis, glabris vel parce pallide pilosis, circiter 2.2 mm. longis et basi 0.6 mm. latis, superne contractis; antheris submembranaceis, aristis inclusis 1.5 mm. longis, per poros ovales apicales dehiscentibus; ovario depresso-globoso, sub anthesi 1.5–2.5 mm. diametro, pilis minutis dense molliter induto; stylo crasso circiter 3 mm. longo, stigmate minute lobato.

Type, *Purdie*, collected in the Quindio region of Colombia and deposited in the herbarium of the Royal Botanic Gardens, Kew. Duplicate at Y. The indument of the new species is strikingly similar to that of *G. strigosa* Benth., from which the small revolute leaves and shorter inflorescences serve to distinguish it.

GAULTHERIA BRACTEATA (Cav.) G. Don Gen. Syst. **3:** 840. 1834. *Andromeda bracteata* Cav. Ic. **6:** 42. *pl. 562, f. 1.* 1801. *Gaultheria pichinchensis* Benth. Pl. Hartw. 225. 1846. This species has not been well understood. In the Delessert herbarium there is a sheet bearing this inscription: "*Andromeda bracteata* Ic. tab. 562, ex montibus Chimborazo et Tunguragua. Gaultheria erecta? Vent. Hort. Cels. Exemplaire type envoye par Cavanilles." This is doubtless a fragment of the actual type of *G. bracteata*. A comparison of this specimen with the type of *G. pichinchensis* leaves no doubt of their similarity. The species is characterized by the dense ferruginous villose hairs of young branchlets and lower surfaces of leaves. It grows over a wide range at altitudes of 3000–4000 meters, and is represented by:

VENEZUELA: Merida: *Linden 407* (C). Sierra Nevada, *Funck & Schlim 1070* (C).
COLOMBIA: *Purdie* (K). Norte de Santander: Eastern slope of Páramo de Santurbán, *Killip & Smith 19610* (Y). El Cauca: Páramo de la Union, *André 2930* (K, Y). Mt. Pan de Azucar, *Pennell 7032* (B, K, Y). Paletara, *Pennell 6951* (Y). Nariño: Alto de Arando, *Triana 2643* (B, C, K).
ECUADOR: *Jameson* (C). *Fraser* (BM, C). *Sodiro* (B). "Mt. Chimborazo and Tunguragua," *Collector?* (C, type coll.). Pichincha: Mt. Pichincha, *Hartweg 1228* (B, BM, C, K, type of *G. pichinchensis*); *Hall* (B), *72* (K); *André 3862* (K), *K. 777* (K); *Jameson* (K), *157* (K); *Lehmann 488* (BM). Vicinity of Quito, *Jameson* (B, C, K), *310* (BM, C, K). Tunguragua: Mt. Tunguragua, *Spruce 5156* (BM, C, K). Chimborazo: Mt. Chimborazo, *Whymper*, (BM).
PERU: Huanuco: Monzon, *Weberbauer 3377* (B).

Gaultheria vegasana sp. nov. Frutex 1–3 m. altus; ramis ramulisque subteretibus fuscis, arcte puberulis et pilis ferrugineis glandulosis ad 1.5 mm. longis plus minusve persistentibus setosis; petiolis rugosis setosis 2–5 mm. longis; laminis subcoriaceis ovatis, 2.5–4 cm. longis, 1.8–2.2 cm. latis, basi rotundatis, apice acutis et calloso-mucronatis, margine leviter revolutis subintegris vel crenulatis, supra maturitate subglabris et nervis puberulis, subtus pilis villosis ferrugineis ad 2.5 mm. longis indutis, pinnatinerviis, nervis secundariis plerumque 3-jugis adscendentibus, cum costa supra planis vel leviter impressis subtus elevatis, venulis reticulatis planis vel leviter elevatis; inflorescentia axillari racemosa 10–16-flora; rhachide 2.5–3 cm. longa, parce puberula ac etiam pilis densis ferrugineis glandulosis circiter 1 mm. longis praedita, basi bracteata; pedicellis 4–5 mm. longis velut rhachide puberulis et villosis, bracteis subcoriaceis obovatis subtentis (bracteis 5–7 mm. longis, 3–5 mm. latis, extra et margine dense glanduloso-villosis, intus glabris), bracteolis

linearibus villosis circiter 3 mm. longis bibracteolatis; floribus pilis paucis decidue glandulosis ad 0.5 mm. longis setosis; calycis lobis deltoideo-ovatis acutis sub anthesi 1.5–2 mm. longis et 1.5 mm. latis; corolla campanulato-cylindrica maturitate circiter 5 mm. longa et 4 mm. diametro, lobis obtusis circiter 0.8 mm. longis; staminibus 10, circiter 3.5 mm. longis; filamentis stramineis ligulatis 2–2.5 mm. longis, pilos delicatulos gerentibus; antheris aristis brevibus inclusis circiter 1.5 mm. longis; ovario depresso-globoso sub anthesi 2–2.5 mm. diametro, minute villoso; stylo carnoso circiter 3 mm. longo apice incrassato, stigmate truncato.

Type, *Killip & Smith 15825*, collected Dec. 20 or 21, 1926, along edge of woods in mountains east of Las Vegas, Department of Santander, Colombia, alt. 3000–3300 meters, and deposited in the herbarium of the New York Botanical Garden. Duplicate at N. Field notes indicate that the calyx lobes are red and the corolla pinkish white. It is related to *G. bracteata* (Cav.) G. Don, from which species it differs in the shape of the bracts, which are dorsally glandular-pilose rather than glabrous, and in the sparsely setose rather than glabrous corollas. It is also to be compared with *G. vestita* Benth., a species with more exaggerated pubescence of branchlets and inflorescence and with the leaves cordate at base.

Gaultheria santanderensis sp. nov. Frutex parvus ad 2 m. altus vel saepe subprostratus; ramulis subteretibus, juventute pallide puberulis ac etiam pilis paucis brevibus glandulosis setosis, mox glabrescentibus; petiolis crassis subrugosis decidue puberulis 2–4 mm. longis; laminis coriaceis late ovatis, 2.5–4.5 cm. longis, 2–3.5 cm. latis, basi cordatis, apice subacutis et calloso-mucronatis, margine serrulatis (dentibus circiter 15 per centimetrum), supra juventute parce puberulis mox glabris et nitidis, subtus pilis tomentosis densis gracilibus stramineis ad 1 mm. longis indutis demum glabrescentibus, pinnatinerviis, nervis secundariis plerumque 3-jugis arcuatis, cum costa supra impressis subtus elevatis, venulis copiose reticulatis; inflorescentia prope apices ramulorum axillari, racemosa 8–16-flora; rhachide 1.5–4.5 cm. longa, arcte puberula ac etiam pilis densis gracilibus stramineis glandulosis ad 1 mm. longis setosa, basi bracteata; pedicellis 7–13 mm. longis velut rhachide puberulis et setosis, bracteis ovatis decidue setosis 6–10 mm. longis subtentis, bracteolis similibus deciduis circiter 4 mm. longis bibracteolatis; floribus partibus exterioribus ubique tomentosis, pilis ferrugineis 0.5–1.5 mm. longis saepe minute glandulosis; calycis lobis 5 elongato-deltoideis acutis, sub anthesi 4–5 mm. longis et basi 3 mm. latis; corolla late cylindrica, maturitate 8–9 mm. longa et circiter 5 mm. diametro, lobis 5 obtusis circiter 1 mm. longis; staminibus 10, circiter 6 mm. longis; filamentis stramineis ligulatis 4–4.5 mm. longis et prope basin ad 1 mm. latis, pilos delicatulos circiter 0.3 mm. longos gerentibus; antheris oblongis, aristis circiter 0.5 mm. longis inclusis 3–3.5 mm. longis; ovario subgloboso sub anthesi 2.5–3 mm. diametro, minute puberulo; stylo carnoso circiter 5 mm. longo, stigmate truncato.

Type, *Killip & Smith 17303*, collected Jan. 16–20, 1927, on open rocky hillside near Vetas, Department of Santander, Colombia, alt. 3100–3250 meters, and deposited in the herbarium of the New York Botanical Garden. Duplicate at N. Other Colombian collections, at an altitude of 3000–3800 meters and by the same collectors unless otherwise noted, are: Norte de Santander: Páramo de Pamplona, *Purdie* (K). Santander: Páramo Rico, near Vetas, *17663* (N, Y). Western slope of Páramo Rico, *17215* (N, Y), *17745* (N, Y). Páramo de las Vegas, *15681* (N, Y). Field notes indicate that the calyx becomes deep red with age, the corolla varying from pale to deep pink.

It is a very distinct species, readily distinguished from others of Colombia by the soft tomentum of the leaves, and by its unusually large and densely pubescent flowers. Its relationship is probably with *G. vestita* Benth., which species has much smaller and shorter-petioled flowers. The leaves of *G. vestita* are setose beneath, while those of *G. santanderensis* usually bear softer hairs. However, of the above-cited specimens, nos. *15681* and *17745* show a tendency towards setose pubescence. In inflorescence *G. santanderensis* may be compared with the Ecuadorean *G. lanigera* Hook., than which species it has leaves more than twice as large, differently shaped, and plane rather than conspicuously revolute at margins.

Gaultheria Pennellii sp. nov. Frutex ramosus; ramulis teretibus, juventute pilis ferrugineis nigrescenti-glandulosis circiter 2 mm. longis dense setosis, demum glabrescentibus; petiolis subrugosis 3–5 mm. longis, velut ramulis setosis; laminis coriaceis oblongis, 3.5–5 cm. longis, 1.7–3.5 cm. latis, basi subcordatis, apice subacutis et calloso-mucronatis, margine crenulatis, supra subglabris et nitidis, subtus et margine pilis setosis glandulosis deciduis 0.5–1 mm. longis indutis, pinnatinerviis, nervis secundariis 3- vel 4-jugis arcuato-adscendentibus, cum costa supra impressis subtus prominentibus, venulis copiose reticulatis; inflorescentia prope apices ramulorum axillari racemosa, 10–16-flora; rhachide gracili 3–4 cm. longa, basi bracteata, dense setosa (pilis ferrugineis nigrescenti-glandulosis ad 0.8 mm. longis) ac etiam minute pallide puberula; pedicellis gracilibus 5–10 mm. longis, velut rhachide setosis et puberulis, bracteis coriaceis oblongis circiter 5 mm. longis (bracteis ciliis crassis glandulosis vel laxis pallidus fimbriatis) subtentis, prope medium bracteolis minoribus similibus bibracteolatis; calyce tenuiter coriaceo, juventute velut pedicello pubescente demum glabrescente, lobis 5 deltoideis, sub anthesi circiter 2 mm. longis et 1.5 mm. latis, acuminatis, margine persistenter fimbriatis; corolla rubra tenuiter carnosa breviter cylindrica, maturitate 4.5–5 mm. longa et 3–3.5 mm. diametro, pilis circiter 0.8 mm. longis glandulososetosa, lobis 5 deltoideis subacutis, circiter 1 mm. longis et latis; staminibus 10, 3–3.5 mm. longis; filamentis pallide castaneis circiter 2.3 mm. longis laxe pilosis; antheris aristis brevibus inclusis circiter 1.3 mm. longis, per poros

latos dehiscentibus; ovario depresso-globoso, sub anthesi circiter 1.5 mm. diametro, glabro vel parce pilosulo; stylo circiter 3 mm. longo, stigmate subtruncato.

Type, *Pennell 4341*, collected Feb. 24, 1918, in shrub zone below Páramo de Chaquiro, Cordillera Occidental, Department of Bolivar, Colombia, alt. 2800–3100 meters, and deposited in the herbarium of the New York Botanical Garden. Other collections, from the neighboring Department of Antioquia, are: Alto San José, alt. about 3000 meters, *Kalbreyer 1587* (B, K); vicinity of Medellín, *R. R. White* (K). It is a species allied to *G. vestita*. Benth., which has the pubescence, especially of calyces, more pronounced and persistent than the new species. *G. vestita* has the calyx lobes pilose within, the ovary densely pilose, the leaves proportionately broad, and the petioles very short, in which characters it contrasts with *G. Pennellii*..

Gaultheria hapalotricha sp. nov. Frutex subprostratus nanus (specimina nostra ad 20 cm. alta); ramulis teretibus, juventute pilis ferrugineis decidue glandulosis ad 2 mm. longis setosis mox glabrescentibus; petiolis teretibus decidue setosis 2–3 mm. longis; laminis coriaceis olivaceis obovatis, 2.5–3.5 cm. longis, 1.7–2.5 cm. latis, basi acutis vel subattenuatis, apice rotundatis et calloso-apiculatis, margine integris et leviter incrassatis, utrinque pilis ferrugineis decidue glandulosis circiter 1 mm. longis adscendentibus vel patulis indutis, demum glabrescentibus, pinnatinerviis, nervis secundariis plerumque 3-jugis rectis adscendentibus, e costa prope basin orientibus, cum costa supra leviter impressis subtus elevatis, venulis inconspicue reticulatis; inflorescentia prope apices ramulorum axillari, breviter racemosa, 6–12-flora; rhachide 5–12 mm. longa parce setosa, basi bracteata; pedicellis gracilibus 3–6 mm. longis, pilis stramineis patulis densis circiter 0.4 mm. longis praeditis, bracteis subcoriaceis decidue puberulis oblongis 5–6 mm. longis subtentis, bracteolis similibus 3–4 mm. longis decidue bibracteolatis; calyce pilis pallidis nigrescenti-glandulosis circiter 0.8 mm. longis praedito, lobis 5 ovato-deltoideis acuminatis minute pallide ciliolatis, sub anthesi circiter 3 mm. longis et 2 mm. latis; corolla breviter cylindrico-urceolata molliter carnosa, maturitate 6–7 mm. longa et 3.5–4.5 mm. diametro, superne contracta, velut calyce parce pilosa, lobis 5 ovato-deltoideis obtusis; staminibus 10, 4.5–5 mm. longis; filamentis stramineis ligulatis circiter 4 mm. longis et prope basin 0.5 mm. latis, superne contractis, pilis pallidis delicatulis circiter 0.3 mm. longis parce pilosis; antheris castaneis membranaceis, aristis brevibus inclusis 0.8–1 mm. longis, per poros ovales subapicales dehiscentibus; ovario subgloboso sub anthesi 1.5–2 mm. diametro, minute puberulo; stylo carnoso circiter 2.7 mm. longo, stigmate subtruncato.

Type, *Killip & Smith 19626*, collected Feb. 20, 1927, on sandy soil at edge of woods on the eastern slope of Páramo de Santurbán, toward

Mutiscua, Department of Norte de Santander, Colombia, alt. 3600–3900 meters, and deposited in the U. S. National Herbarium (no. 1,354,823). Another collection is *Tracey 485* (K), collected on Páramo de Choachi, Department of Cundinamarca, alt. 3100 meters. The fact that only these two widely separated stations are known indicates the sparsely collected character of the intervening páramos. It is a very distinctive species, probably best grouped with *G. odorata* Willd. and its allies, with which it has in common a pilose corolla. However, our species is readily distinguished by its dwarfed habit, its obovate acute-based leaves with ascending veins, and its acuminate calyx lobes. The calyx is bright pink without and pale pink or white within. The hairs of pedicel and calyx, when these organs are boiled, are seen to be extraordinarily delicate and pale, bearing minute black glands. The corolla is pale pink and of an unusually delicate texture, as are the pale slender filaments.

Gaultheria psilantha sp. nov. Frutex ramosus; ramulis subteretibus striatis fuscis glabris; petiolis subrugosis incrassatis glabris 1.5–3 mm. longis; laminis coriaceis margine excepto glabris oblongis, 3.5–5.5 cm. longis, 2–3 cm. latis, basi truncatis vel subcordatis, apice acutis et calloso-mucronatis, margine serratis (dentibus 6–9 per centimetrum, ciliis rigidis deciduis 1–1.5 mm. longis terminatis), pinnatinerviis, nervis secundariis 3- vel 4-jugis, arcuato-adscendentibus, cum costa supra elevatis subtus prominentibus, venulis copiose reticulatis utrinque elevatis; inflorescentia apices ramulorum versus axillari racemosa 10–22-flora; rhachide crassa 2–7 cm. longa minute pallide puberula basi bracteata; pedicellis subteretibus 5–10 mm. longis minute pallide puberulis, bracteis coriaceis subglabris oblongis acutis 5–8 mm. longis subtentis, prope basin bracteolis minoribus similibus bibracteolatis; calyce subcoriaceo subglabro (margine decidue pallide puberulo), lobis 5 ovato-deltoideis acutis, sub anthesi 4–4.5 mm. longis et 2.5–3 mm. latis; corolla pallide rubescente tenuiter carnosa glabra breviter cylindrica, maturitate circiter 8 mm. longa et 4 mm. diametro, lobis 5 deltoideis obtusis, circiter 1.5 mm. longis et latis; staminibus 10 circiter 5 mm. longis; filamentis stramineis minute puberulis, 3–3.5 mm. longis, basi circiter 0.8 mm. latis, superne contractis; antheris fusco-castaneis submembranaceis, aristis circiter 0.5 mm. longis inclusis 2–2.3 mm. longis, per poros latos dehiscentibus; ovario subgloboso, sub anthesi circiter 2.5 mm. diametro, minute pallide piloso; stylo crasso quam corolla paullo breviore.

Type, *Pennell 2067*, collected Sept. 20, 1917, on the dry and grassy Páramo de Cruz Verde, near Bogotá, Department of Cundinamarca, Colombia, alt. 3400–3600 meters, and deposited in the herbarium of the New York Botanical Garden. Other collections, also from Cundinamarca, are: Páramo de Choachi, alt. 3300 meters, *Tracey 486* (K); a páramo near

Bogotá, *Schultze 24* (B). The latter specimen has the pedicels subtended by lanceolate-oblong bracts up to 12 mm. long. It is of the relationship of *G. rigida* HBK., from which species it differs by having the leaf venation coarser and more obvious, the inflorescence more robust in all parts, and the texture of bracts, calyces and corollas more coriaceous.

Gaultheria antioquiensis sp. nov. Frutex; ramulis teretibus fuscis, juventute minute pallide puberulis demum glabrescentibus; petiolis subrugosis subteretibus 4–7 mm. longis, velut ramulis puberulis; laminis coriaceis olivaceis (vel subtus rubentibus) oblongo-ovatis, 6–9 cm. longis, 2.5–4 cm. latis, basi acutis vel subobtusis saepe petiolis decurrentibus, apice subacutis callosomucronatis, margine serrato-crenatis (dentibus 12–14 per centimetrum nigroapiculatis), supra maturitate glabris, subtus conspicue glanduloso-punctatis, pinnatinerviis, nervis secundariis 3- vel 4-jugis adscendentibus, cum costa supra impressis subtus prominentibus, venulis reticulatis supra obscuris subtus elevatis; inflorescentia axillari racemosa 15–25-flora; rhachide gracili tereti, dense albo-puberula ac etiam parce fusco-glanduloso-pilosa (pilis circiter 0.3 mm. longis), basi bracteis arcte imbricatis dense circumdata; pedicellis gracilibus 3–6 mm. longis, velut rhachide puberulis et parce glandulosis, bracteis subcoriaceis prominenter striatis oblongo-spatulatis 10–15 mm. longis subtentis (bracteis juventute puberulis, margine glanduloso-pilosis, apice acutis), bracteolis patulis similibus linearibus 3–4 mm. longis prope basin bibracteolatis; calyce parce puberulo vel glabro, lobis 5 deltoideis acutis, sub anthesi 2–3 mm. longis et 2 mm. latis; corolla breviter cylindrico-urceolata submembranacea glabra, maturitate 6 mm. longa et 4–5 mm. diametro, lobis 5 deltoideis obtusis; staminibus 10, 3.5–4 mm. longis; filamentis stramineis ligulatis circiter 2.5 mm. longis et prope basin 0.5 mm. latis; antheris membranaceis, aristis inclusis circiter 1.3 mm. longis; ovario depresso-globoso subglabro sub anthesi 2.5 mm. diametro; stylo circiter 3 mm. longo, stigmate subtruncato.

Type, *R. A. Toro 984*, collected Feb. 1, 1928, at Tamesis, near Medellín, Department of Antioquia, Colombia, and deposited in the herbarium of the New York Botanical Garden. Other collections, also from Antioquia, are: San José, *Kalbreyer 1586* (B, K); Santa Elena, *Archer 635* (N). It is a species allied to *G. rigida* H.B.K., from which it differs by having the leaves acute rather than cordate at base. The densely glandular-punctate lower leaf surfaces, the conspicuously striate bracts, and the slender spreading bractlets are also characteristic of the new species.

Gaultheria microdonta sp. nov. Frutex compactus; ramis ramulisque subteretibus fuscis mox cinerascentibus, juventute minute puberulis ac etiam pilis castaneis 0.6 mm. longis setosis, demum glabrescentibus; petiolis rugosis decidue setosis 2–3 mm. longis; laminis coriaceis olivaceis oblongis, 20–28 mm. longis, 7–12 mm. latis, basi rotundatis vel subtruncatis, apice subacutis et

calloso-mucronatis, margine leviter incrassatis et serrulatis (dentibus circiter 15 per centimetrum, ciliis rigidis deciduis terminatis), supra glabris, subtus pilis stramineis patulis 1–1.5 mm. longis setosis, pinnatinerviis, costa supra impressa subtus elevata, nervis secundariis 3- vel 4-jugis brevibus, venulis reticulatis supra subplanis subtus leviter elevatis; inflorescentia prope apices ramulorum axillari, racemosa 8–15-flora; rhachide gracili 1.5–2 cm. longa, velut ramulis puberula et setosa, basi bracteis parvis circumdata; pedicellis gracilibus 4–8 mm. longis puberulis et setosis (setis minute glandulosis), bracteis subglabris lanceolato-oblongis 4–6 mm. longis subtentis, bracteolis similibus 3.5–4 mm. longis decidue bibracteolatis; calyce carnoso minute albo-puberulo, lobis 5 deltoideis acutis sub anthesi circiter 3.5 mm. longis et 2 mm. latis; corolla tenuiter carnosa subcylindrica, maturitate 6–7 mm. longa et 3–4 mm. diametro, superne contracta, velut calyce puberula, lobis 5 obtusis circiter 1 mm. longis; staminibus 10, circiter 4 mm. longis; filamentis stramineis ligulatis circiter 2.5 mm. longis, pilos delicatulos circiter 0.3 mm. longos gerentibus; antheris membranaceis, aristis inclusis 1.5–2 mm. longis, per poros ovales subapicales dehiscentibus; ovario subgloboso sub anthesi circiter 2 mm. diametro, dense puberulo; stylo 3.5–4 mm. longo, stigmate truncato.

Type, *Brother Ariste-Joseph A301*, collected in October, 1907, at Montserrate, Department of Cundinamarca, Colombia, and deposited in the U. S. National Herbarium (no. 1,067,860). It is a species most closely related to *G. brachybotrys* DC., from which it differs by the smaller leaves which are less conspicuously pilose beneath, the narrower inflorescence bracts, the longer calyx lobes, and the pale-puberulous rather than glabrous corollas.

Gaultheria alnifolia (Dun.) comb. nov. *Thibaudia alnifolia* Dun.; DC. Prodr. **7:** 564. 1839. *Gaultheria Lindeniana* Planch. Fl. des Serres I. **5:** 501D. 1849. *Proclesia alnifolia* Kl. Linn. **24:** 35. 1851. *Chupalon alnifolium* Ktze. Rev. Gen. Pl. **2:** 384. 1891. *Cavendishia alnifolia* Hoer. Bot. Jahrb. Engl. **42:** 273. 1909. The present species is readily distinguished from others of the region by its reddish-brown leaves and branchlets, and by the obovate leaves, which are attenuate at base and rounded or apiculate at apex. It is well described and figured by Planchon, of whose species *Linden 36* is probably the type collection. The type specimen of Dunal's species is sterile, but its position here is unmistakable. It is represented by:

VENEZUELA: without definite locality: *Karsten 9* (B). Las Lagunetas, *Moritz 1591* (BM). Miranda: El Cedral de las Ajuntas, near Los Teques, 1000–1800 m., *Pittier 6115* (B, Y). Federal District: Caracas and vicinity, *Vargas* (C, type); *Linden 36* (BM, C, K, P, type of *G. Lindeniana*), *315* (P); *Birschel* (K); *Funck 354* (C, P); *Funck & Schlim 122* (BM, C, P); *Gollmer* (B); *Allart 99* (C, Y). Aragua: Colonia Tovar, *Fendler 740* (C, K, Y); *Moritz 353* (B, BM, C).

VACCINIACEAE

Vaccinium Benthamianum nom. nov. *Anthopterus mucronatus* Benth. Pl. Hartw. 221. 1846; not *Vaccinium mucronatum* L. (1753). *Thibaudia mucronata* Hoer. Bot. Jahrb. Engl. **42:** 274. 1909. Examination of the type of *Anthopterus mucronatus* indicates that it is a species of *Vaccinium* of the alliance of *V. polystachyum* Benth., from which it differs by having the calyx obviously angled, the inflorescence slightly longer, and the leaves entire and revolute at margins and conspicuously mucronate at apex. It is represented by:

COLOMBIA: Tolima: Quindio region, 2800–3450 m., *Triana 2656* (BM, C, K, P, Y); *André 2218* (K, Y). El Cauca: Cordillera Pitayo, near Popayan, *Hartweg 1210* (BM, K, type).

Allied to *V. Benthamianum* are two recently collected species here described. The three species, which form a distinct group within the genus, may be distinguished from one another thus:

Flowers solitary or in pairs; pedicels 3–4 mm. long; calyces and young corollas brown-pilose; calyx limb distinctly lobed..... *V. anfractum*

Flowers glabrous, short-racemose, 2–4 per inflorescence; pedicels 5–8 mm. long; calyx limb short-apiculate..... *V. Pennellii*

Flowers glabrous, racemose, 8–15 per inflorescence; calyx limb distinctly lobed ..... *V. Benthamianum*

Vaccinium anfractum sp. nov. Frutex parvus; ramulis subpendulis teretibus anfractis, juventute pilis ferrugineis ad 0.4 mm. longis villosis; petiolis rugosis villosis 1–2 mm. longis; laminis coriaceis ovatis, 15–20 mm. longis, 7–11 mm. latis, basi rotundatis vel obtusis, apice acutissimis callosis, margine integris subcartilagineis, utrinque glabris vel parce breviter glandulososetosis, e basi obscure 3–5-nerviis, costa utrinque plana vel supra impressa, nervis secundariis et venulis obscuris; floribus axillaribus solitariis vel binis; pedicellis subrugosis rectis parce villosis 3–4 mm. longis, cum calyce continuis, prope basin bracteolis ovatis ad 0.8 mm. longis bibracteolatis; calyce coriaceo, pilos patulos ferrugineos circiter 0.5 mm. longos gerente, tubo obprismatico 5-angulato sub anthesi circiter 3 mm. longo et 2.5 mm. diametro, limbo suberecto, lobis inclusis 1.5 mm. longo, lobis 5 deltoideis acutis circiter 0.8 mm. longis; corolla molliter carnosa parce villosa vel glabra cylindrica, 8–10 mm. longa, 3–3.5 mm. diametro, 5-lobata, lobis oblongis subacutis circiter 1.5 mm. longis; staminibus 10 aequalibus quam corolla paullo brevioribus; filamentis distinctis ligulatis circiter 4 mm. longis superne pilosis; antheris membranaceis tubulis inclusis circiter 5 mm. longis, tubulis quam loculis paullo longioribus, per rimas ad 1.5 mm. longas dehiscentibus; stylo corollam subaequante, stigmate subcapitato.

Type, *Pennell 7446*, collected June 29 or 30, 1922, in shrub-zone ("paramillo") on Mt. Santa Ana, Department of El Cauca, Colombia, alt. 2700–3000 meters, and deposited in the herbarium of the New York Botanical Garden. It is a species without close relatives in the northern Andes other than the following new species, from which it is readily distinguished as noted in the above key.

Vaccinium Pennellii sp. nov. Frutex parvus plus minusve decumbens; ramulis subteretibus juventute parce puberulis mox glabrescentibus; petiolis rugosis subglabris 1.5–2.5 mm. longis; laminis coriaceis ovatis, 15–23 mm. longis, 7–11 mm. latis, basi obtusis vel truncatis, apice obtusis sed mucronatis, margine leviter revolutis, subintegris vel crenulatis, utrinque glabris et parce punctatis, e basi obscure 3–5-nerviis, costa supra impressa subtus elevata, nervis secundariis adscendentibus supra leviter impressis, venulis obscuris; inflorescentia axillari breviter racemosa glabra 2–4-flora; rhachide 2–5 mm. longa, basi minute bracteata; pedicellis gracilibus subrugosis 5–8 mm. longis, cum calyce continuis, bracteis anguste ovatis ad 1 mm. longis subtentis, infra medium bracteolis similibus bibracteolatis; calycis tubo obprismatico 5-angulato sub anthesi 3–3.5 mm. longo et diametro, limbo erecto lobis inclusis 1.5–2 mm. longo, lobis 5 breviter apiculatis; corolla cylindrica apice contracta, 8–9 mm. longa, 4–5 mm. diametro, 5-lobata; staminibus 10 aequalibus quam corolla paullo brevioribus; filamentis distinctis stramineis ligulatis glabris circiter 3.5 mm. longis; antheris tubulis inclusis 5.5–6 mm. longis, tubulis elongato-conicis flexilibus quam loculis paullo longioribus, per rimas 1–2 mm. longas dehiscentibus; stylo corollam subaequante, stigmate subtruncato.

Type, *Pennell 10522*, collected Sept. 8–10, 1922, in shrub zone below páramo on Cerro Tatama, Department of Caldas, Colombia, alt. 3300–3500 meters, and deposited in the herbarium of the New York Botanical Garden. Other collections, also from Colombia, are: Bolivar: below Páramo de Chaquiro, 2800–3100 m., *Pennell 4316* (Y). Bolivar-Antioquia Boundary: Páramo de Chaquiro, 3000–3200 m., *Pennell 4288* (Y). Tolima: Cerro Pelado, 2684 m., *Stuebel 249b* (B).

Ceratostema Pearcei (Britton) comb. nov. *Rusbya Pearcei* Britton, Bull. Torr. Club **20:** 68. 1893. *Anthopterus Pearcei* Drude; Engl. & Prantl, Pflanzenfam. Nachtr. **4**[1]: 270. 1897. The present species was excluded from the genus *Rusbya* in a recent paper,[1] but until the present I have not been able to place it with accuracy. Examination of the type specimen indicates that it is a *Ceratostema*, most closely allied to *C. buxifolium* Field. & Gardn., from which it differs by having the leaves uniformly larger and subacute rather than rounded at apex. A more detailed description than the original is here published:

[1] Contr. U. S. Nat. Herb. **28:** 446. 1932.

Compact epiphytic shrub; branchlets cinereous, striate, sparsely puberulous when young, glabrescent, swollen at petioles; stipules lanceolate, 3–5 mm. long, deciduous; petioles violaceous, slender, about 1 mm. long; leaf blades subcoriaceous, oblong, 15–22 mm. long, 5–9 mm. broad, rounded at base, subacute at apex, entire at margins, glabrous above, sparsely and deciduously pilose beneath with minute stiff nigrescent hairs, obscurely pinnate-veined, the secondary veins 1 or 2 per side, oriented near base; flowers axillary, solitary or in pairs, essentially glabrous in all parts; pedicels slender, subrugose, 6–12 mm. long, circumscribed at base by several minute subpuberulous bractlets, continuous with calyx; calyx tube obconical, subrugose, 2–3 mm. long, about 2 mm. in diameter at summit, 5-angled or narrowly 5-winged, the limb subspreading, about 2 mm. long including lobes, the lobes 5, ovate-deltoid, 1–1.5 mm. long, acute, deciduously pilose at margins; corolla thin-carnose, subcylindric, 6–8 mm. long, about 3 mm. in diameter, the lobes 5, deltoid, minute; stamens alternately slightly unequal, nearly as long as corolla; filaments castaneous, 1.5–2 mm. long, minutely pilose at margins; anther sacs slightly granular, about 2 mm. long; tubules flexible, 4–4.5 mm. long, opening by elongate clefts; style about as long as corolla, the stigma truncate.

BOLIVIA: La Paz: Pintac, 3100–3400 m., *Pearce* (K, type). Sandillani, 2500–2800 m., *Pearce* (K). Cochabamba: Incachaca, 2300 m., *Steinbach 8986* (Y).

Semiramisia fragilis sp. nov. Frutex gracilis epiphyticus; ramulis subteretibus juventute pallide puberulis mox cinerascentibus glabrescentibus; petiolis subglabris subteretibus rugosis 1.5–2 mm. longis; laminis coriaceis ovato-suborbicularibus, 15–28 mm. longis, 11–18 mm. latis, basi apiceque rotundatis, margine integerrimis crassis et leviter recurvatis, pilis rigidis adpressis deciduis parce indutis, supra nitidis subtus opacis, obscure 5-pli-nerviis, nervis secundariis prope basin orientibus adscendentibus, cum costa supra leviter elevatis subtus immersis, venulis obscuris; floribus axillaribus ut videtur solitariis; pedicellis gracilibus flexuosis 15–20 mm. longis, pilis pallidis patulis ad 0.5 mm. longis indutis, prope medium decidue bibracteolatis (bracteolis oblongis circiter 0.7 mm. longis), cum calyce continuis; calyce ut pedicello dense piloso, tubo obconico sub anthesi circiter 2 mm. longo et 1.5 mm. diametro, limbo suberecto, lobis inclusis 1–1.5 mm. longo, lobis 5 ovato-deltoideis subacutis circiter 1 mm. longis et latis; corolla tenuiter carnosa dense pilosa (pilis pallidis circiter 0.3 mm. longis), cylindrico-urceolata, 23–24 mm. longa, prope basin 4–5 mm. diametro superne contracta apice patula, 5-lobata, lobis ovatis subacutis, circiter 1.5 mm. longis, 2.5 mm. latis; staminibus 10 aequalibus corollam aequantibus; filamentis distinctis (leviter cohaerentibus et basi seriebus duabus imbricatis), castaneis carnosis glabris, 4–5 mm. longis, ad antheras connectivis brevibus gracilibus annexis; loculis leviter granulatis basi subacutis 2–3 mm. longis; tubulis membranaceis gracilibus (superne 0.25 mm. diametro), 17–18 mm. longis, per rimas obliquas 0.5 mm.

longas dehiscentibus; stylo leviter exserto filiformi superne incrassato, stigmate truncato.

Type, *Lehmann K.276*, collected in November, 1890, at Huahuidocal, West Andes of Cuenca, Province of Azuay, Ecuador, alt. 1800–2500 meters, and deposited in the herbarium of the Royal Botanic Gardens, Kew. Another Ecuadorean collection is: Río Amarollo, *André 4304* (F, K, Y). It is a species which in foliage and habit suggests *Oreanthes buxifolius* Benth., but the stamens are 10 rather than 5 and the calyx has neither the elongate tube nor lobes of *Oreanthes*. The facts that the short-lobed calyx is continuous with the pedicel and that the 10 stamens terminate in long slender tubules points to an alliance with *Semiramisia*. Here it is most suggestive of the Venezuelan *S. Karsteniana* Kl., but in the present species the calyx is small, the characteristic large campanulate corolla is much reduced, and the leaves are small and rounded at apex. It might well be considered generically distinct, but since the fundamental features are those of *Semiramisia*, it seems best to expand the concept of that genus to include the present species.

Psammisia caloneura sp. nov. Frutex; ramis ramulisque subteretibus fuscis minute fusco-puberulis glabrescentibus, internodiis bracteas (folias reductas?) hic illic gerentibus, bracteis submembranaceis lanceolato-oblongis sessilibus acutis 8–17 mm. longis, velut foliis minimis nervatis, nunc inflorescentiam subtentibus nunc solitariis; petiolis subteretibus decidue fusco-puberulis incrassatis, 3–7 mm. longis, 2.5–4 mm. diametro; laminis subcoriaceis ovato-oblongis, 18–30 cm. longis, 6.5–15 cm. latis, basi rotundatis vel late cuneatis, apice longe acuminatis, margine integerrimis, glabris (saepe nervis principalibus minute puberulis), pinnatinerviis, costa crassa supra plana vel elevata subtus prominentissima, nervis secundariis 12–20-jugis (nervis tertiariis fere aeque prominentibus alternantibus), subrectis patulis prope margines conspicue anastomosantibus, supra leviter impressis subtus prominentissimis, venulis crebre reticulatis, utrinque leviter elevatis; inflorescentia ramulis infra folia plerumque exoriente, saepe in axillis bractearum supra descriptarum, subfasciculata vel breviter racemosa (rhachide ad 5 mm. longa), ubique subglabra, 2–6-flora; pedicellis subrugosis nigrescentibus 6–13 mm. longis, bracteis coriaceis ovatis 1–1.5 mm. longis subtentis, prope basin decidue bibracteolatis; calycis tubo campanulato nigrescente sub anthesi 2.5–3 mm. longo et diametro, limbo coriaceo suberecto lobis inclusis circiter 2 mm. longo, lobis 5 ovatis apiculatis circiter 1 mm. longis et 2 mm. latis; corolla urceolata 8–9 mm. longa, prope basin circiter 4 mm. diametro superne contracta, lobis 5 oblongis subacutis circiter 1 mm. longis et latis; staminibus 10 aequalibus circiter 5.5 mm. longis; filamentis tenuiter carnosis castaneis distinctis, glabris vel intus superne parce puberulis, circiter 0.8 mm. longis, in connectivos angustiores productis, connectivis superne alternatim bicalcaratis,

calcaribus subacutis quam connectivis paullo latioribus; loculis basi incurvatis acutisque 2–2.5 mm. longis; tubulis cylindrico-conicis, circiter 2 mm. longis, per rimas breves dehiscentibus; stylo maturo exserto, stigmate subcapitato.

Type, *Triana 2690*, collected in May, 1853, between Barbacoas and Tuquerres, Department of Nariño, Colombia, alt. 900 meters, and deposited in the herbarium of the British Museum. Duplicates at K, P. It is a very distinct species which, in the numerous pinnate veins of its large leaves, bears but little resemblance to other Thibaudieae. I have not observed inter-nodal bracts, such as those above described, elsewhere in the tribe. The flowers are distinctly psammisioid, and the general appearance of the plant suggests *Psammisia Sodiroi* Hoer., which is doubtless its nearest relative. In addition to the characters above mentioned, *P. caloneura* is distinguished from *P. Sodiroi* by its fewer-flowered inflorescences and smaller flowers.

Thibaudia densiflora (Herzog) comb. nov. *Hornemannia densiflora* Herzog Med. Rijks. Herb. Leiden **27:** 21. 1915. This species, originally placed in *Hornemannia* because of its alliance to *H. boliviensis* Ktze. (*Thibaudia boliviensis* (Ktze.) Hoer.), is more closely related to *T. regularis* A. C. Smith, from which it differs by having its broader leaves rounded rather than attenuate at base, its bractlets larger, and its calyces considerably more robust. The type collection (Bolivia: Incacorral, 2200 m., *Herzog 2250*) is represented at B and C.

Themistoclesia recurva sp. nov. Frutex gracilis (epiphyticus?); ramulis elongatis subteretibus gracilibus cinereis juventute parce puberulis; petiolis nigrescentibus rugosis 2–3 mm. longis decidue puberulis; laminis coriaceis anguste ovatis, 4.5–5.5 cm. longis, 1.5–2 cm. latis, basi rotundatis vel obtusis, apice acuminatis, margine integris et leviter recurvatis, utrinque subglabris, subtus decidue parce puberulis et fusco-strigosis, e basi obscure 3–5-nerviis, costa supra impressa subtus prominente superne obscure ramosa, nervis secundariis adscendentibus utrinque planis, venulis obscuris; inflorescentiis longe racemosis 1–3 in axillis foliorum, 6–12-floris; rhachide gracili flexili recurva 3–9 cm. longa, decidue cinereo-puberula; floribus glabris mox deciduis; pedicellis flexilibus subrugosis 15–20 mm. longis superne incrassatis, bracteis deciduis oblongis circiter 1 mm. longis subtentis, prope medium minute bibracteolatis, cum calyce continuis; calyce obconico, tubo carnoso-angulato, sub anthesi circiter 3 mm. longo et 2.5 mm. diametro, limbo patulo lobis inclusis 1–1.5 mm. longo, lobis apiculatis; corolla campanulata, 4.5–5 mm. longa, circiter 4 mm. diametro, lobis ovato-deltoideis, circiter 2 mm. longis et latis; staminibus subaequalibus circiter 3.5 mm. longis; filamentis nigrescentibus glabris circiter 1 mm. longis; antheris 2.7–3 mm. longis, tubulis latis loculos aequantibus, per rimas 0.8 mm. longas dehiscentibus; stylo crasso ad 4 mm. longo, stigmate truncato.

Type, *Pennell 9306*, collected Aug. 2–10, 1922, in forest at Pinares, above Salento, Department of Caldas, Colombia, alt. 2600–2800 meters, and deposited in the herbarium of the New York Botanical Garden. Other collections, also from Colombia, are: Tolima: *Goudot* (P). Pan de Azucar, 2800–3000 m., *Linden 920* (C, P). It is a species readily distinguished from others of the genus by its elongate recurved racemes, from which the scattered flowers are soon deciduous. The leaves are proportionately narrower than those of other species.

Themistoclesia rostrata sp. nov. Frutex glaber gracilis (epiphyticus?); ramis ramulisque teretibus elongatis subscandentibus; petiolis rugosis circiter 2 mm. longis; laminis coriaceis ovatis, 7–10 cm. longis, 2.5–3.5 cm. latis, basi rotundatis vel leviter subcordatis, apice longe acuminatis (acumine ad 2 cm. longo), margine integris, utrinque glabris, 5-pli-nerviis, costa supra impressa subtus prominente, nervis secundariis prope basin orientibus adscendentibus, supra leviter impressis subtus planis vel elevatis, venulis plus minusve obscuris; inflorescentiis breviter racemosis 3–5 in axillis foliorum, 3- vel 4-floris; rhachide gracili 2–4 mm. longa; floribus mox deciduis, juventute partibus exterioribus parce ferrugineo-strigosis; pedicellis gracilibus 10–15 mm. longis, bracteis oblongis ad 1 mm. longis subtentis, infra medium minute bibracteolatis, cum calyce continuis; calyce obprismatico, tubo carnoso-angulato, 2.5–3 mm. longo et sub anthesi circiter 2.5 mm. diametro, limbo patulo lobis inclusis 1–1.5 mm. longo, lobis breviter apiculatis; corolla tenuiter carnosa subglobosa, 7–8 mm. longa, 4–6 mm. diametro, basi apiceque contracta, lobis deltoideis 1–1.5 mm. longis; staminibus subaequalibus 5–6 mm. longis; filamentis distinctis stramineis circiter 2 mm. longis, pilos patulos ad 0.5 mm. longos superne gerentibus; antheris tubulis inclusis circiter 5 mm. longis, tubulis latis loculos aequantibus, per rimas ovales ad 1 mm. longas dehiscentibus; stylo crasso quam corolla paullo breviore, stigmate truncato.

Type, *Pennell 2664*, collected Oct. 29, 1917, in forest below El Peñon, southwest of Sibaté, Department of Cundinamarca, Colombia, alt. 2600–2800 meters, and deposited in the herbarium of the New York Botanical Garden. Field notes indicate that the corolla is bright red, paler distally. Other collections, also from Cundinamarca, are: Fusagasuga, 2500 m., *Triana 2717* (C, P). Between Sibaté and Fusagasuga, *Linden 830* (C, P). Near Bogotá, *Goudot* (P). It is a species related to *T. pendula* Kl. and *T. dependens* (Benth.) A. C. Smith, from both of which it differs by its lax subscandent habit, its larger leaves, and its shorter distinctly subglobose corollas. The long-caudate leaves are well-spaced on the slender branchlets.

Cavendishia coccinea sp. nov. Frutex gracilis; ramulis subteretibus juventute minute cinereo-puberulis demum glabrescentibus et fuscescentibus;

petiolis subglabris rugosis 4–6 mm. longis; laminis crasse coriaceis ovatis, 4–6 cm. longis, 1.5–2.5 cm. latis, basi acutis, apice longe caudato-acuminatis, margine integerrimis et leviter revolutis, glabris, supra nitidis, 5-pli-nerviis, costa supra plana vel impressa subtus elevata, nervis secundariis prope basin orientibus arcuatis, utrinque leviter elevatis, venulis reticulatis leviter elevatis vel obscuris; inflorescentia terminali vel axillari racemosa, 6–12-flora, basi bracteis parvis deciduis instructa; rhachide subtereti glabra 4–9 cm. longa; floribus glabris ut videtur in axillis bractearum alternarum solitariis, bracteis membranaceis glabris late ovatis, 2–3.5 cm. longis, 1.5–2.5 cm. latis, basi obtusis atque sessilibus, apice longe caudato-acuminatis (acumine 5–8 mm. longo), margine glandulosis (glandulis sessilibus, 6–8 per centimetrum, dentes minutos terminantibus), reticulato-nerviis; pedicellis subteretibus, 3–6 mm. longis, minute decidue bibracteolatis; calyce coriaceo subnigrescente, tubo campanulato, sub anthesi 2.5 mm. longo et 3 mm. diametro, limbo suberecto subcampanulato, lobis inclusis 4–5 mm. longo, lobis late deltoideis subacutis, 1.5 mm. longis, 3–4 mm. latis, glandulis coriaceis linearibus 1.5 mm. longis superne marginatis, sinibus rotundatis; corolla late cylindrica submembranacea, maturitate 30–35 mm. longa, circiter 6 mm. diametro, apice contracta, lobis 5 subnigrescentibus deltoideis 0.5 mm. longis; staminibus quam corolla paullo brevioribus; filamentis casteneis membranaceis, basi subcohaerentibus, glabris vel superne parce pilosis, alternatim 3 mm. et 9 mm. longis; loculis granulatis circiter 5 mm. longis; tubulis membranaceis amplis, alternatim 18–19 mm. et 13 mm. longis, per rimas elongatas dehiscentibus; stylo circiter 0.7 mm. diametro, stigmate truncato.

Type, *Triana 2698*, collected in February, 1853, at Acostadero, Cordillera del Chocó, Intendencia of El Chocó, Colombia, alt. 2500 meters, and deposited in the herbarium of the British Museum. Duplicates at C, K, P. Possibly *Jervise* (K), collected in Antioquia, without inflorescence, also represents the species. *C. coccinea* is another example of the remarkably distinct character of many plants of the Antioquia-El Chocó Andes. It has no close relatives, but may be compared with *C. adenophora* Mansf., with which it has in common an elongate calyx tube and glandular-margined bracts, but from which it differs in leaf shape and size, shape of bracts, method of inflorescence, size of flowers, etc. The delicate brilliant red bracts and large corollas of *C. coccinea* make its introduction to horticulture desirable.

Cavendishia rhynchophylla sp. nov. Frutex gracilis; ramulis subteretibus striatis decidue cinereo-puberulis; petiolis teretibus subnigrescentibus decidue puberulis 2–4 mm. longis; laminis coriaceis ovatis vel ovato-oblongis, 5–8 cm. longis, 2–3 cm. latis, basi rotundatis, apice longe caudato-acuminatis, margine integerrimis, subglabris, 5 (obscure 7)-pli-nerviis, nervis secundariis supra basin orientibus, arcuato-adscendentibus, cum costa supra fere planis

subtus elevatis, venulis copiose reticulatis, saepe supra elevatis; inflorescentia terminali vel axillari, racemosa, 8–15-flora, basi decidue bracteata; rhachide angulata glabra 3–6 cm. longa; pedicellis striatis parce puberulis 5–12 mm. longis, bracteis submembranaceis oblongis sessilibus subglabris ad 10 mm. longis subtentis, prope basin decidue minute bibracteolatis; florum partibus exterioribus ubique pilis uniformibus patulis cinereis 0.3–0.4 mm. longis pilosis; calycis tubo breviter cylindrico, sub anthesi circiter 1 mm. longo et 3 mm. diametro, superne constricto, limbo suberecto, lobis inclusis circiter 2.5 mm. longo, lobis deltoideis acutis, circiter 1 mm. longis, 3–4 mm. latis, apice callosis; corolla cylindrica maturitate 11–13 mm. longa, 4 mm. diametro, lobis deltoideis acutis circiter 1 mm. longis; staminibus quam corolla paullo brevioribus; filamentis castaneis glabris distinctis, alternatim 2 mm. et 4 mm. longis; loculis granulatis circiter 3 mm. longis; tubulis alternatim circiter 7 mm. et 6 mm. longis, per rimas elongatas dehiscentibus; stylo corollam aequante, stigmate truncato.

Type, *Triana 2676*, collected in July, 1853, at San Antonio, Western Cordillera, Department of El Valle, Colombia, alt. 1800 meters, and deposited in the herbarium of the British Museum. Duplicates at C, P, Y. It is a distinct species, probably most closely allied to *C. Lindauiana* Hoer., *C. hispida* A. C. Smith, and *C. callista* Donn. Sm., from all of which it is distinguished by smaller flowers and leaves and by pilose calyces. It may also be sought among the species allied to *C. cordifolia* (HBK.) Hoer., from which group it differs by its elongate inflorescence, long calyx limb, callose-tipped calyx lobes, and by various foliage aspects.

Cavendishia Gleasoniana sp. nov. Frutex; ramulis subteretibus striatis gracilibus violaceis glabris (juventute minute puberulis); petiolis crassis rugosissimis decidue pilosis 4–7 mm. longis; laminis oblongis coriaceis bullatissimis, 7–12 cm. longis, 4–5.5 cm. latis, basi cordatis, apice caudato-acuminatis (? specimine nostro incompleto), margine integerrimis et anguste revolutis, supra subglabris subtus pilosis, pilis setosis cinereis circiter 1 mm. longis, 5–7-pli-nerviis, nervis secundariis supra basin orientibus, jugo summo cum costa prope apicem rejuncto, jugis inferioribus arcuato-adscendentibus, cum costa supra impressis subtus prominentibus, venulis copiose reticulatis utrinque elevatis; inflorescentia axillari breviter racemosa pauciflora, ubique glabra, basi bracteis imbricatis oblongo-ovatis papyraceis ad 2.5 cm. longis instructa; rhachide circiter 1 cm. longa; pedicellis subrugosis 5–8 mm. longis, basi bractea decidua eis basi rhachidis simili subtentis, prope basin decidue bibracteolatis, superne incrassatis et cum calyce articulatis; calycis tubo rugoso breviter cylindrico subapophysato, sub anthesi circiter 2 mm. longo et 3 mm. diametro, limbo erecto, cum lobis 3–4 mm. longo, lobis deltoideis, 1–1.5 mm. longis et latis, apice callosis; corolla submembranacea cylindrica, 20–25 mm. longa, circiter 4 mm. diametro; staminibus subaequalibus (filamentis anther-

isque compensanter inaequalibus), circiter 23 mm. longis; filamentis castaneis distinctis, brevioribus 2–3 mm. longis et glabris, longioribus gracilibus 6–8 mm. longis et superne parce pilosis; loculis leviter granulatis 5–8 mm. longis; tubulis flexilibus alternatim 15–18 mm. et 11–13 mm. longis, per rimas elongatas dehiscentibus; stylo filiformi corollam aequante, stigmate truncato.

Type, *Schomburgk*, collected in the vicinity of Mount Roraima, British Guiana, and deposited in the herbarium of the Royal Botanic Gardens, Kew. It allies itself to those *Cavendishias* with elongate calyx limb and callose-thickened lobes. It agrees with the Andean *C. bomareoides* A. C. Smith in having its leaves pilose beneath, but differs in having the leaves decidedly bullate, the inflorescence shorter and fewer-flowered, and the flowers smaller in all parts. It is also closely related to *C. duidae* A. C. Smith, the only other *Cavendishia* known from the Pacaraima Mountains, but differs in its bullate leaves which are proportionately broader and its shorter fewer-flowered inflorescences.

Cavendishia caulialata (R. & P.) comb. nov. *Thibaudia caulialata* R. & P. Fl. Peruv. Chil. **4:** *pl. 386*. 1802. *Thibaudia alata* Dun.; DC. Prodr. **7:** 562. 1839. *Andromeda alata* Domb. ex Dun.; DC. Prodr. **7:** 562. 1839, as syn. *Vaccinium alatum* Domb. ex Dun.; DC. Prodr. **7:** 562. 1839, as syn. *Proclesia alata* Kl. Linn. **24:** 34. 1851. *Chupalon alatum* Ktze. Rev. Gen. Pl. **2:** 384. 1891. *Cavendishia alata* Hoer. Bot. Jahrb. Engl. **42:** 279. 1909. In the herbarium of the Museum d'Histoire Naturelle, Paris, there are six sheets collected by Dombey which have been referred to *Thibaudia punctata* R. & P. and *Thibaudia alata* Dun. Of these, four are *Cavendishia punctatifolia* (R. & P.) Hoer. and two are *C. caulialata*, agreeing with the plate of Ruiz and Pavon. These two specimens (one of which, collected at Huasa-Huasi, Department of Junín, Peru, is doubtless the type), differ from *C. punctatifolia* by their shortened inflorescence and short stout campanulate corollas. The broadly winged branchlets readily distinguish the species from other *Cavendishias*. The necessity for the above combination was implied in a recent publication.[1]

Cavendishia sophoclesioides sp. nov. Frutex parvus compactus epiphyticus; ramulis cinereis subteretibus juventute parce pallide puberulis mox glabrescentibus; petiolis subrugosis subteretibus decidue puberulis 2–3 mm. longis; laminis crasse coriaceis glabris, subtus dense luteo-glandulosis, ovato-suborbicularibus, 12–15 mm. longis, 8–9 mm. latis, basi apiceque rotundatis, margine integerrimis et crassis, obscure nervatis, costa supra subimpressa subtus elevata, nervis secundariis utroque latere saepe 2, e basi adscendentibus immersis; floribus axillaribus solitariis subsessilibus arcte bracteatis, bracteis

[1] Contr. U. S. Nat. Herb. **28:** 312, 509. 1932.

10–20 glabris (margine parce puberulis) oblongo-subspatulatis, maximis et interioribus ad 15 mm. longis et 7 mm. latis; pedicellis circiter 2 mm. longis, bractearum basibus occultis; calyce obconico margine excepto glabro, tubo sub anthesi circiter 2 mm. longo et apice 2.5 mm. diametro, limbo suberecto, lobis inclusis circiter 2.5 mm. longo, lobis deltoideis 1–1.5 mm. longis, basi circiter 2 mm. latis, acutis, margine dense fimbriatis (pilis castaneis, 0.5 mm. longis, basi intercohaerentibus); corolla subcylindrica carnosa glabra coccinea (apice lutea?), circiter 20 mm. longa et 4–5 mm. diametro, lobis oblongis, circiter 3 mm. longis et basi 2 mm. latis, subacutis; staminibus subaequalibus circiter 16 mm. longis; filamentis castaneis superne pilos pallidos patulos circiter 0.3 mm. longos gerentibus, alternatim 1.5 mm. et 2.5 mm. longis; antheris alternatim 15 mm. et 14 mm. longis, loculis subgranulatis circiter 3.5 mm. longis, tubulis flexilibus per rimas elongatas dehiscentibus; stylo corollam aequante, stigmate subcapitato.

Type, *Pennell 4354*, collected Feb. 24, 1918, in shrub zone below Páramo de Chaquiro, Western Cordillera, Department of Bolivar, Colombia, alt. 2800–3100 meters, and deposited in the herbarium of the New York Botanical Garden. It is a species very remote from any other known *Cavendishia*, characterized by the solitary subsessile individually bracteate flowers and the small suborbicular leaves. It may be compared in method of inflorescence only to *C. sessiliflora* A. C. Smith, but that species has the inflorescence pubescent, the flowers smaller, the leaves larger and attenuate at base, and many other striking points of difference. The present species has the two staminal series sometimes practically similar.

Satyria polyantha sp. nov. *Polyboea polyantha* Griseb.; Lechl. Berb. Am. Austr. 58. 1857, nomen. *Eurygania polyantha* Benth. & Hook. Gen. Pl. **2**: 568. 1876, nomen. *Thibaudia polyantha* Hoer. Bot. Jahrb. Engl. **42**: 276. 1909, nomen. *Cavendishia polyantha* Griseb.; Hoer. Bot. Jahrb. Engl. **42**: 276. 1909, as synonym. Frutex parvus; ramulis rigidis cinereis teretibus, juventute minute pallide puberulis mox glabrescentibus; petiolis decidue puberulis subrugosis, 4–7 mm. longis, superne anguste alatis; laminis coriaceis ellipticooblongis, 4–6 cm. longis, 2–2.5 cm. latis, basi cuneatis, apice acutis vel subacutis, margine integerrimis et crassis, supra glabris vel nervis parce puberulis, subtus pilos laxos cinereos circiter 0.5 mm. longos gerentibus, pinnatinerviis, costa et nervis secundariis supra impressis subtus prominentibus, nervis secundariis utroque latere 2 vel 3, arcuato-adscendentibus, jugis inferioribus longissimis, venulis obscure reticulatis; inflorescentiis multis axillaribus 10–25-floris, ubique partibus exterioribus dense et persistenter cinereo-tomentosis (pilis circiter 0.5 mm. longis); rhachide striata 1–3 cm. longa, basi bibracteolata et bracteolis subtenta (bracteolis ovato-oblongis, 2–4 mm. longis, pilis crassis glandulosis circiter 0.2 mm. longis decidue marginatis); calycis tubo campanulato 1.5–2 mm. longo, sub anthesi 2–2.5 mm. diametro, limbo erecto-

patente, lobis inclusis 1–1.5 mm. longo, lobis 5 breviter deltoideis apiculatis, basi circiter 2 mm. latis; corolla breviter cylindrica (juventute subglobosa), 3.5–5 mm. longa, 2–2.5 mm. diametro, lobis 5 deltoideis minutis; staminibus 10 alternatim circiter 3.5 mm. et 4 mm. longis; filamentis castaneis glabris connatis circiter 1 mm. longis; antheris basi minute setosis, alternatim circiter 2.7 mm. et 3.2 mm. longis, apice dilatatis, per rimas elongatas ovales dehiscentibus, tubulis quam loculis paullo longioribus; stylo crasso quam corolla breviore, stigmate truncato.

Type, *W. Lechler 2068*, collected in June, 1854, at Tabina, Department of Puño, Peru, and deposited in the herbarium of the Royal Botanic Gardens, Kew. Duplicates at Bo, P. Other collections, also from the Department of Puño, are: Between Ollachea and Tabina, *Raimondi 9650* (B); Between Sandia and El Valle Grande, *Raimondi 8996* (B). According to the latter collector, the plant is locally known as "Huihuito" and the fruit is edible. This species forms with its only close ally, *S. neglecta* A. C. Smith of Bolivia, a very distinct group. It is readily distinguished from *S. neglecta* by its pubescent inflorescence, its broader leaves pilose beneath, and by other obvious characters of foliage and inflorescence.

Satyria cerander (Dun.) comb. nov. *Thibaudia cerander* Dun.; DC. Prodr. **7:** 565. 1839. The type of this species, which was inadequately described by Dunal, was probably collected in French Guiana by Leblond. Examination of the type collection establishes the fact that it is a *Satyria*, closely related to *S. panurensis* (Benth.) B. & H., from which it differs by its shorter more slender inflorescence and shorter flaring corollas. The corollas apparently never exceed 10 mm. in length, while those of *S. panurensis* at maturity are rarely as short as 16 mm. The presence of a species of the tribe *Thibaudieae* in French Guiana is noteworthy; previously the mountains of British Guiana have been considered the eastern limit of the tribe. The following description is based upon the cited collections:

Glabrous shrub; branchlets subterete, fuscous or cinereous; petioles rugose, 3–5 mm. long; leaf blades coriaceous, ovate-oblong, 7–12 cm. long, 3–5 cm. broad, rounded at base, acuminate at apex, entire at margins, somewhat nitid, 5-pli-nerved, the costa nearly plane above, prominent beneath, the secondary nerves oriented near base, plane or slightly raised above, raised beneath, the veinlets copiously reticulate, nearly plane; inflorescence axillary, racemose, 4–7-flowered; rachis terete, slender, 6–15 mm. long; pedicels subrugose, 7–12 mm. long, subtended by minute deciduous bracts and minutely bibracteolate near middle; calyx tube campanulate, about 1.5 mm. long and in diameter at anthesis, the limb spreading, 1–1.3 mm. long including the short apiculate lobes; corolla thin-carnose, 8–10 mm. long, 2 mm. in diameter near

base, flaring to about 3.5 mm. in diameter at apex, the lobes erect, deltoid, subacute, about 1 mm. long and 2 mm. broad; stamens about 5 mm. and 6 mm. long respectively; filaments castaneous, glabrous, 1.5–2 mm. long, produced into ligulate connectives; anthers about 4.5 and 5.5 mm. long respectively, slender at base, flaring distally, opening by broad oval clefts about 2 mm. long; style exserted at maturity, the stigma truncate.

FRENCH GUIANA: *Leblond?* (P, herb. Jussieu no. 7575, type). *Leblond*, in 1792 (P). Maroni, *Mélinon 138* (P, Y).

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE
1929–1932

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Amidei, T. P. The anatomy of the leaf of *Panicum palmifolium*. Bull. Torrey Club **59**: 491–499. *f. 1–11*. 1 N 1932.

Andrews, F. M. A measurement of growth. Proc. Indiana Acad. Sci. **41**: 77–81. 1932.

Armitage, E. Bryological notes on a West Indies cruise. Bryologist **35**: 23–28. Mr 1932.

Atwell, C. B. Three dune associations compared. Torreya **32**: 109–115. S–O 1932.

Bancroft, H. Herbs, herbals, herbalists. Some sketches from the history of medical botany in the Old World. Sci. Monthly **35**: 239–253. *f. 1–9*. S 1932.

Bartram, E. B. Mosses of northern Guatemala and British Honduras. Jour. Washington Acad. Sci. **22**: 476–482. *f. 1*. 19 O 1932.

Includes description of *Campylopus Bartletti*, sp. nov.

Beadle, G. W. Studies of *Euchlaena* and its hybrids with *Zea*. I. Chromosome behavior in *Euchlaena mexicana* and its hybrids with *Zea Mays*. Zeits. Induk. Abst. u. Vererb. **62**: 291–304. *pl. 1–4+f. 1–4*. 1932.

Benke, H. C. New asters from Illinois. Am. Midl. Nat. **13**: 326–328. S 1932.

Berkholder, W. H. Carbohydrate fermentation by certain closely related species in the genus *Phytomonas*. Phytopathology **22**: 699–707. Au 1932.

Bennett, C. W. Further observations and experiments with mosaic diseases of raspberries, blackberries, and dewberries. Michigan Agr. Exp. Sta. Tech. Bull. 125: 1–32. *f. 1–6*. Au 1932.

Bennett, H. H. Relation of erosion to vegetative changes. Sci. Monthly **35**: 385–415. *f. 1–25*. N 1932.

Blasberg, C. H. Phases of the anatomy of *Asparagus officinalis*. Bot. Gaz. **94**: 206–214. *f. 1–10*. 5 O 1932.

Blunt, G. M. The structure of chromosomes of *Zea Mays* as revealed by the Feulgen reaction. Science II. **76**: 372. 21 O 1932.

Bödecker, F. *Mammillaria Weingartiana* Böd., sp. n. Monats. Deutsch. Kakteen-Gesell. **4**: 219–220. *illust.* O 1932.
A Mexican plant.

Bressman, E. N. *Lolium* infected with bunt of wheat. Phytopathology **22**: 865–866. *f. 1.* O 1932.

Briggs, F. N. Inheritance of resistance to bunt, *Tillitia Tritici*, in hybrids of White Federation and Odessa wheat. Jour. Agr. Res. **45**: 501–505. *f. 1.* 15 O 1932.

Brooks, C. & others. Effect of solid and gaseous carbon dioxide upon transit diseases of certain fruits and vegetables. U. S. Dep. Agr. Tech. Bull. 318: 1–59. *f. 1–34.* S 1932.

Brown, M. S. *Entosthodon neoscoticus* sp. nov. Bryologist **35**: 17–18. Mr 1932.

Burkett, G. W. Anatomical studies within the genus *Hydrangea*. Proc. Indiana Acad. Sci. **41**: 83–95. *pl. 1–3.* 1932.

Cain, S. A. Plants of Spring Mill State Park, Lawrence County, Indiana; I. Ferns. Proc. Indiana Acad. Sci. **41**: 97–98; II. Trees, shrubs and woody vines. 99–104. 1932.

Cain, S. A. Studies on virgin hardwood forest: I. Density and frequency of the woody plants of Donaldson's woods, Lawrence County, Indiana. Proc. Indiana Acad. Sci. **41**: 105–122. *f. 1–7.* 1932.

Carpenter, E. I. The viability of cultures of *Rhizopus nigricans*. Mycologia **24**: 512–514. 1 N 1932.

Chardon, C. E. New or interesting tropical American Dothideales. III. Jour. Dep. Agr. Puerto Rico **16**: 167–192. *pl. 14–16.* Ap 1932.

Christensen, C. Cultural races and the production of variants in *Pestalozzia funerea*. Bull. Torrey Club **59**: 525–544. *f. 1–5.* 1 D 1932.

Christophersen, E. A collection of plants from the Galapagos Islands. Nyt. Mag. Naturv. **70**: 67–95. *pl. 1.* 1931.

Chrysler, M. A. A new cycadeoid from New Jersey. Am. Jour. Bot. **19**: 679–692. *pl. 48, 49.* 31 O 1932.

Clute, W. N. Seed distribution in *Fraxinella*. Am. Bot. **38**: 167–169. *illust.* O 1932.

Cochran, L. C. A study of two *Septoria* leaf spots of celery. Phytopathology **22**: 791–812. *f. 1–4.* O 1932.

Coker, W. C., & Totten, H. R. Notes on extended ranges of plants in North Carolina. Jour. Elisha Mitchell Sci. Soc. **48**: 138–140. O 1932.

Conard, H. S. Mosses of Pine Hollow, Iowa. Bryologist **35**: 28–30. Mr 1932.

Cook, M. T. *Marasmius Sacchari;* a parasite on sugar cane. Jour. Dep. Agr. Puerto Rico **16**: 213–226. *pl. 19–23.* Ap 1932.

Cook, M. T. *Thielaviopsis paradoxa;* an important disease of sugar cane. Jour. Dep. Agr. Puerto Rico **16**: 205–211. Ap 1932.

Cotter, R. U. Factors affecting the development of the aecial stage of *Puccinia graminis*. U. S. Dep. Agr. Tech. Bull. 314: 1–37. *pl. 1–5.* Au 1932.

Cotter, R. U., & Levine, M. N. Physiologic specialization in *Puccinia graminis secalis*. Jour. Agr. Res. **45**: 297–315. *f. 1–4.* 1 S 1932.

Davis, J. J. Notes on parasitic fungi in Wisconsin. XIX. Trans. Wisconsin Acad. Sci. **27**: 183–192. 1932.

Davy, J. B., & Sandwith, N. Y. *Mouriria Marshallii*. Kew Bull. Misc. Inf. **1932**: 317–318. 1932.
A new species from Trinidad.

Deam, C. C. Plants new or rare in Indiana. XVII. Proc. Indiana Acad. Sci. **41**: 123. 1932.

Demaree, D. Plant responses to sawdust. Proc. Indiana Acad. Sci. **41**: 125–126. 1932.

Dermen, H. Cytological studies of *Cornus*. Jour. Arnold Arbor. **13**: 410–416. *pl. 53.* O 1932.

Deuber, C. Chemical treatments to shorten the rest period of red and black oak acorns. Jour. Forest. **30**: 674–679. O 1932.

Doak, C. C. Multiple male cells in *Cupressus arizonica*. Bot. Gaz. **94**: 168–182. *f. 1–17.* 5 O 1932.

Douglass, A. E. Tree rings and their relation to solar variations and chronology. Smithsonian Inst. Ann. Rep. **1931**: 304–312. *pl. 1–5.* 1932.

Drechsler, C. A species of *Pythiogeton* isolated from decaying leaf-sheaths of the common cat-tail. Jour. Washington Acad. Sci. **22**: 421–449. *f. 1–5.* 19 S 1932.

Eastwood, A. *Cypripedium fasciculatum* in California. Leafl. West. Bot. **1**: 22–23. 21 S 1932.

Eastwood, A. The fetid adder's tongue. Leafl. West. Bot. **1**: 24. 21 S 1932.

Eaton, F. M. Boron requirements of cotton. Soil Sci. **34**: 301–305. O 1932.

Elias, M. K. Grasses and other plants from the Tertiary rocks of Kansas and Colorado. Univ. Kansas Sci. Bull. **20**: 333–366. *pl. 30.* My 1932.

Emerson, R. A., & Beadle, G. W. Studies of *Euchlaena* and its hybrids with *Zea*. II. Crossing over between the chromosomes of *Euchlaena* and those of *Zea*. Zeits. Induk. Abst. u Vererb. 62: 305–315. 1932.

Emerson, S. Chromosome rings in *Oenothera*, *Drosophila* and maize. Proc. Nat. Acad. **18**: 630–632. O 1932.

Farr, W. K., & Clark, G. L. Cotton fibers II. Structural features of wall suggested by x-ray diffraction analyses and observations in ordinary and plane-polarized light. Contr. Boyce Thompson Inst. **4**: 273–295. *f. 1–4*. S 1932.

Fassett, N. C. Preliminary reports on the flora of Wisconsin. XVI. Xyridales. Trans. Wisconsin Acad. Aci. **27**: 227–230. *f. 1–6*; XVII. Myricaceae, Juglandaceae. 231–234. *f. 1–6*.; XIX. Saxifragaceae. 237–246. *f. 1–18*. 1932.

Fernald, M. L. *Diarrhena festucoides*. Rhodora **34**: 204–207. 8 O 1932.

Fernald, M. L. Notes on *Festuca octoflora*. Rhodora **34**: 209–211. 8 O 1932.

Fernald, M. L. *Phragmites communis* Trin. var. *Berlandieri* (Fournier) comb. nov. Rhodora **34**: 211–212. O 1932.

Fernald, M. L., & Weatherby, C. A. *Picea rubens* Sarg. forma *virgata* (Rehder) comb. nov. Rhodora **34**: 211. 8 O 1932.

Foster, A. S. Investigations on the morphology and comparative history of development of foliar organs. IV. The prophyll of *Carya Buckleyi* var. *arkansana*. Am. Jour. Bot. **19**: 710–728. *pl. 50, 51+f. 1–11*. 31 O 1932.

Gabrielson, I. N. A new *Lewisia* from California. New Flora & Silva **5**: 53. *pl. 18*. O 1932.

Gibson, F. *Agave Palmeri* forms "hijos" Desert **4**: 75–76. *illust.* N 1932.

Gilgut, C. J., & Jones, L. H. A demonstration of basal growth. Bot. Gaz. **94**: 221–222. *f. 1*. 5 O 1932.

Gilman, J. C. First supplementary list of parasitic fungi from Iowa. Iowa St. Coll. Jour. Sci. **6**: 357–365. Jl 1932.

Gleason, H. A. The pronunciation of botanical names. Am. Bot. **38**: 183–193. O 1932.

Goodman, G. J. A collection of *Emex* from California. Leafl. West. Bot. **1**: 21. 21 S 1932.

Goodspeed, T. H. Die Bedeutung von quantitativen Chromosomenveränderungen. Naturwiss. **19**: 476–483. 1931.

Graves, G. W. Ecological relationships of *Pinus sabiniana*. Bot. Gaz. **94**: 106–133. *f. 1–14*. 5 O 1932.

Gray, F. W. Pygmies, here and there, now and then. Bryologist **35**: 18–23. Mr 1932.

Greene, H. C. Wisconsin Myxomycetes. Trans. Wisconsin Acad. Sci. **27**: 141–181. *pl. 1–6*. 1932.

Greene, R. A. Composition of the pulp and seeds of *Adansonia digitata*. Bot. Gaz. **94**: 215–220. 5 O 1932.

Guiscafré, J. R. The brown rot fungus in Puerto Rico. Jour. Dep. Agr. Puerto Rico **16**: 193–202. *pl. 17, 18*. Ap 1932.

Gyelnik, V. Über einige Arten der Gattung *Parmeliopsis* (Stizenb.) Nyl. Ann. Myc. **30**: 456–459. 1932.

Parmeliopsis subambigua, sp. nov. from Maryland is included.

Hagen, A. M. Preliminary reports on the flora of Wisconsin. XX. Malvales. Trans. Wisconsin Acad. Sci. **27**: 247–249. *f. 1–6*. 1932.

Hall, E. H. Some preliminary notes on the ecology of the upland communities in the vicinity of Greensboro. Jour. Elisha Mitchell Sci. Soc. **48**: 123–124. O 1932.

Hall, H. M. Heredity and environment—as illustrated by transplant studies. Sci. Monthly **35**: 289–302. *f. 1–8, illust.* O 1932.

Hanna, G. D. Pliocene diatoms of Wallace County, Kansas. Univ. Kansas Sci. Bull. **20**: 369–394. *pl. 31–34*. My 1932.

Harris, H. A. Initial studies of American elm diseases in Illinois. Illinois Nat. Hist. Surv. Bull. 20: 1–70. *f. 1–35*. O 1932.

Harris, T. M. The fossil flora of Scoresby Sound, East Greenland. Meddel. Grønland **85**[3]: 1–112. *pl. 1–9*+*f. 1–39*. 1932.

Helgeson, E. A. Impermeability in mature and immature sweet clover seeds as affected by conditions of storage. Trans. Wisconsin Acad. Sci. **27**: 193–206. 1932.

Hessler, R. A note on *Passiflora lutea* L. Proc. Indiana Acad. Sci. **41**: 133. 1932.

Higgins, E. B. *Acanthocereus pentagonus*. Desert **4**: 80. *illust.* N 1932.

Höhnk, W. A new parasitic *Pythium*. Mycologia **24**: 489–507. *pl. 20*+*f. 1–11*. 1 N 1932.

Holmes, F. O. Movement of mosaic virus from primary lesions in *Nicotiana tabacum* L. Contr. Boyce Thompson Inst. **4**: 297–322. *f. 1–6*. S 1932.

Holmes, F. O. Symptoms of tobacco mosaic disease. Contr. Boyce Thompson Inst. **4**: 323–357. *f. 1–9*. S 1932.

Humphrey, C. J., & Leus-Palo, S. Studies and illustrations in the Polyporaceae. III. Philippine Jour. Sci. **49**: 159–184. *pl. 1–12*. O 1932.

Illick, J. T. Chromosomal configurations of *Oenothera* species and crosses and their probable significance. Bot. Gaz. **94**: 1–50. 5 O 1932.

Janaki-Ammal, E. K. Chromosome studies in *Nicandra physaloides*. La Cellule **41**: 89–110. *pl. 1, 2*. 1932.

Jenkins, A. E. Rose anthracnose caused by *Sphaceloma*. Jour. Agr. Res. **45**: 321–337. *pl. 1–7+f. 1–6*. 15 S 1932.

Jenkins, A. E., & White, R. P. Identification of *Diaporthe umbrina* on rose from England. Mycologia **24**: 485–488. *pl. 18, 19*. 1 N 1932.

Johansen, D. A. *Aptenia cordifolia*. Jour. Cactus & Succ. Soc. Am. **4**: 246. S 1932.

Johansen, D. A. *Stylophyllum attenuatum*. Desert **4**: 76–77. *illust*. N 1932.

Kadow, K. J., & Jones, L. K. *Fusarium* wilt of peas with special reference to dissemination. Washington Agr. Exp. Sta. Bull. 272: 1–30. *pl. 1–4*. Jl 1932.

Kidder, A. F. An unusual cotton plant. Science II. **76**: 295. 30 S 1932.

King, R. Plasmolysis. Proc. Indiana Acad. Sci. **41**: 135–138. 1932.

Kükenthal, G. *Cyperus* (§Luzuloidei) *Altsoni*. Kew Bull. Misc. Inf. **1932**: 322–323. 1932.
From British Guiana.

Kunkel, L. O. Celery yellows of California not identical with the Aster yellows of New York. Contr. Boyce Thompson Inst. **4**: 405–414. *f. 1, 2*. S 1932.

Lachmund, H. G., & Hansbrough, J. R. Preliminary report on the relative susceptibility of sugar pine and western pine to blister rust. Jour. Forest. **30**: 687–691. O 1932.

Lammerts, W. E. Inheritance of monosomics in *Nicotiana rustica*. Genetics **17**: 689–696. *f. 1, 2*. N 1932.

Lanjouw, J. Contributions to the flora of tropical America. XI. Kew Bull. Misc. Inf. **1932**: 183–187. *f. 1, 2*. 1932.

Le Clerg, E. L. Leaf temperature of lettuce and its relation to tipburn. Phytopathology **22**: 851–855. O 1932.

Lemee, A. Dictionnaire descriptif et synonymique des genres de plantes phanérogames. **4**: 1–1071. Brest. 1932.

Lester-Smith, W. C. Citrus mildew. Phytopathology **22**: 870. O 1932.

Ligon, W. S., & Pierre, W. H. Soluble aluminum studies: II. Minimum concentrations of aluminum found to be toxic to corn, sorghum, and barley in culture solutions. Soil Sci. **34**: 307–320. *pl. 1, 2*. O 1932.

Livergood, F. B. Preliminary reports on the flora of Wisconsin. XVIII. Sarraceniales. Trans. Wisconsin Acad. Sci. **27**: 235–236. *f. 1–6.* 1932.

Lloyd, F. E. The range of structural and functional variety in the traps of *Utricularia* and *Polypompholyx*. Flora **126**: 303–328. *f. 1–16.* 1932.

Lohman, M. L. Three new species of *Mytilidion* in the proposed subgenus, *Lophiopsis*. Mycologia **24**: 477–484. *pl. 17+f. 1.* 1 N 1932.

Longmire, A. A. How fasciations are formed. Desert **4**: 67–68. *illust.* O 1932.

Love, L. D., & Hanson, H. C. Life history and habits of crested wheatgrass. Jour. Agr. Res. **45**: 371–383. *f. 1–9.* 15 S 1932.

McCray, F. A. Compatibility of certain *Nicotiana* species. Genetics **17**: 621–636. *f. 1–6.* N 1932.

McCray, F. A. A partially fertile triple species hybrid in *Nicotiana*. Genetics **17**: 660–673. *f. 1–10.* N 1932.

McCulloch, L., & Demaree, J. B. A bacterial disease of the tung-oil tree. Jour. Agr. Res. **45**: 339–346. *f. 1–3.* 15 S 1932.

McFarland, J. H. What is "standardized plant names"? Am. Bot. **38**: 170–177. O 1932.

McWhorter, F. P., & Weiss, F. Diseases of Narcissus. Oregon Agr. Exp. Sta. Bull. 304: 1–41. *f. 1–21.* Je 1932.

Mahony, K. L. Preliminary reports on the flora of Wisconsin. XV. Polygonaceae. Trans. Wisconsin Acad. Sci. **27**: 207–225. *f. 1–42.* 1932.

Mann, M. L. Calcium and magnesium requirements of *Aspergillus niger*. Bull Torrey Club **59**: 443–490. *f. 1–13.* 1 N 1932.

Mansfeld, R. Die Gattung *Catasetum* L. C. Rich. Repert. Spec. Nov. **30**: 257–275. 15 Jl 1932; Repert. Spec. Nov. **31**: 99–125. 30 S 1932.

Martin, G. W. The genus *Protodontia*. Mycologia **24**: 508–511. *f. 1, 2.* 1 N 1932.

Mathews, A. C. The seed development in *Pinus palustris*. Jour. Elisha Mitchell Sci. Soc. **48**: 101–118. *pl. 6–12.* O 1932.

Merrill, E. D. *Solanum Sanitwongsei*. Addisonia **17**: 43–44. *pl. 566.* 28 O 1932.

Metcalf, F. P. Botanical notes on Fukien and southeast China. XIII. Lingnan Sci. Jour. **11**: 263–267. *f. 1–3.* 15 My 1932; XIV. 405–408. 22 Jl 1932.

Miller, E. V., & Brooks, C. Effect of carbon dioxide content of storage atmosphere on carbohydrate transformation in certain fruits and vegetables. Jour. Agr. Res. **45**: 449–459. *f. 1–4.* 15 O 1932.

Morgan, W. P. Growth irregularities in hybrid Freesias induced by x-rays. Proc. Indiana Acad. Sci. **41**: 139–144. *f. 1–4.* 1932.

Mottier, D. M. Studies on *Berberis vulgaris* and related species: I. On seed germination and the survival of seedlings of *Berberis vulgaris* in Monroe County, Indiana. Proc. Indiana Acad. Sci. **41**: 145–148. 1932.

Mousley, H. Further notes on the birds, orchids, ferns and butterflies of the Province of Quebec, 1931. Canadian Field Nat. **46**: 171–173. 1 N 1932.

Murrill, W. A. The hard-skinned puffballs. Nature Mag. **20**: 242. *illust.* N 1932; **21**: 26. *illust.* Ja 1933.

Nelson, R. M. Growth and mortality of chestnut sprouts. Jour. Forest. **30**: 872–873. N 1932.

Nolla, J. A. B. The damping off of tobacco and its control in Puerto Rico. Jour. Dep. Agr. Puerto Rico **16**: 203–204. Ap 1932.

Palm, B. T. Biological notes on *Albugo.* Ann. Myc. **30**: 421–426. *f. 1–3.* 1932.

Palm, B. T. *Eriodendron* as host of *Bacterium Malvacearum.* Phytopathology **22**: 867–868. O 1932.

Palm, B. T. A note on *Entyloma Dahliae* Syd. from Sumatra and Guatemala. Phytopathology **22**: 868–869. O 1932.

Palm, B. T. On *Cyttaria* Berk. and *Cyttariella* n. gen. Ann. Myc. **30**: 405–420. *f. 1–4.* 1932.

Palmer, E. J. *Crataegus Arnoldiana.* Addisonia **17**: 33–34. *pl. 561.* 28 O 1932.

Palmer, E. J. Leaves from a collector's note book. Jour. Arnold Arbor. **13**: 417–437. *f. 1.* O 1932.

Platenius, H. Carbohydrate and nitrogen metabolism in the celery plant as related to premature seeding. Cornell Agr. Exp. Sta. Mem. 104: 1–66. *f. 1–46.* Ap 1932.

Porges, N. Chemical composition of *Aspergillus niger* as modified by zinc sulphate. Bot. Gaz. **94**: 197–205. 5 O 1932.

Porter, C. L. Mixed cultures of bacteria and fungi. Proc. Indiana Acad. Sci. **41**: 149–152. 1932.

Porter, C. L. The pteridophytes of Wyoming. Torreya **32**: 116–118. S–O 1932.

Porter, D. R. Some environmental relations of watermelon wilt. Phytopathology **22**: 813–825. *f. 1–3.* O 1932.

Potzger, J. E. Plants previously unreported from Monroe County, Indiana. Proc. Indiana Acad. Sci. **41**:175–176. 1932.

Potzger, J. E. Some observations on *Pinus virginiana* Mill. in Monroe County, Indiana: an ecological study. Proc. Indiana Acad. Sci. **41**: 153–174. *f. 1–9.* 1932.

Price, W. C. Acquired immunity to ring-spot in *Nicotiana.* Contr. Boyce Thompson Inst. **4**: 359–403. *f. 1–9.* S 1932.

Purdy, C. New species of *Lewisia.* Leafl. West. Bot. **1**: 20, 21. 21 S 1932.

Ransier, H. E. Hunting Scott's spleenwort in Alabama. Am. Fern Jour. **22**: 76–78. Jl-S 1932.

Reed, H. S. Criteria of plant growth and their reliability. Philippine Jour. Agr. **3**: 155–161. 1932.

Reko, B. P. Catalogo de los generos fanerogamos Mexicanos arreglado segun el sistema natural de A. Engler. Mem. Rev. Soc. Cien Antonio Alzate **50**: 123–194. 1929.

Righter, F. I. Bisexual flowers among the pines. Jour. Forest. **30**: 873. *f. 1.* N 1932.

Rodenhiser, H. A. Heterothallism and hybridization in *Sphacelotheca Sorghi* and *S. cruenta.* Jour. Agr. Res. **45**: 287–296. *pl. 1–3+f. 1–5.* 1 S 1932.

Rogers, D. P. A cytological study of *Tulasnella.* Bot. Gaz. **94**: 86–105. *f. 1–79.* 5 O 1932.

Samuel, G., & Garrett, S. D. *Rhizoctonia Solani* on cereals in south Australia. Phytopathology **22**: 827–836. *f. 1–5.* O 1932.

Sandwith, N. Y. *Ruyschia phylladenia* Sandwith. Kew Bull. Misc. Inf. **1932**: 299–300. 1932.

Scheuber, L. M. A cytological study of *Timmia cucullata.* La Cellule **41**: 147–162. *pl. 1, 2.* 1932.

Scholz, R. Microchemical studies of the changes during vernal activity in *Ginkgo biloba.* Jour. Elisha Mitchell Sci. Soc. **48**: 133–137. O 1932.

Schopmeyer, H. H. Production of yeast growth stimulants by molds on various media. Iowa St. Coll. Jour. Sci. **6**: 471–472. Jl 1932.

Scott, F. M. Some features of the anatomy of *Fouquieria splendens.* Am. Jour. Bot. **19**: 673–678. *f. 1–7.* 31 O 1932.

Sefferien, M. L. Wild flowers of the Spuyten-Duyvil and Riverdale sections of New York City. Torreya **32**: 119–127. S-O 1932.

Small, J. K. Asiatic immigrants in the Botanical Garden. I. Jour. N. Y. Bot. Gard. **33**: 226–228. O 1932.

Small, J. K. The crux of twisted and contorted tree-trunks. Jour. N. Y. Bot. Gard. **33**: 189–195. *f. 1–4*. S 1932.

Small, J. K. *Ilex myrtifolia*. Addisonia **17**: 39–40. *pl. 564*. 28 O 1932.

Small, J. K. Natural grafts. Jour. N. Y. Bot. Gard. **33**: 213–219. *f. 1–4*. O 1932.

Small, J. K. *Polycodium floridanum*. Addisonia **17**: 35–36. *pl. 562*. 28 O 1932.

Small, J. K. *Solanum Blodgettii*. Addisonia **17**: 41–42. *pl. 565*. 28 O 1932.

Small, J. K. *Tamala littoralis*. Addisonia. **17**: 45–46. *pl. 567*. 28 O 1932.

Smith, B. H. The algae of Indiana. Proc. Indiana Acad. Sci. **41**: 177–206. 1932.

Smith, W. K. Reaction of Martin wheat to three physiologic forms of *Tilletia Tritici*. Phytopathology **22**: 847–850. *f. 1, 2*. O 1932.

Stapf, O. *Ourisia alpina*. Curt. Bot. Mag. IV. **155**: *pl. 9287*. 8 O 1932.

A South American plant.

Stapf, O. *Salvia mexicana f. minor*. Curt. Bot. Mag. IV. **155**: *pl. 9285*. 8 O 1932.

Stebbins, G. L. Cytology of *Antennaria*. I. Normal species. Bot. Gaz. **94**: 134–151. *f. 1–32*. 5 O 1932.

Stokes, S. G. A new species of *Eriogonum*. Leafl. West Bot. **1**: 23. 21 S 1932.

Stone, W. E. The origin, development, and increase of chloroplasts in the potato. Jour. Agr. Res. **45**: 421–435. *pl. 1–10* +*f. 1–6*. 1 O 1932.

Stuckert, T. Las Malvaceas Argentinas. An. Soc. Cien. Argentina **114**: 99–115. S 1932.

Studhalter, R. A. The elusive ruffle plant, *Riella*. Sci. Monthly **35**: 303–311. *f. 1, 2*. O 1932.

Tapke, V. F. An undescribed loose smut of barley. Phytopathology **22**: 869–870. O 1932.

Teuscher, H. *Lonicera Morrowii xanthocarpa*. Addisonia **17**: 37–38. *pl. 563*. 28 O 1932.

Teuscher, H. *Virburnum Wrightii*. Addisonia **17**: 47–48. *pl. 568*. 28 O 1932.

Thatcher, R. W. Some new aspects of plant nutrition. Science II. **76**: 281–285. 30 S 1932.

Thut, H. F. The movement of water through some submerged plants. Am. Jour. Bot. **19**: 693–709. *f. 1, 2*. 31 O 1932.

Torrey, R. H. Another report of *Marchantia polymorpha* after forest fires. Torreya **32**: 128–129. S-O 1932.

Wadmond, S. C. *Phymosia remota* in captivity. Rhodora **34**: 207–209. O 1932.

Weaver, J. E., & Kramer, J. Root system of *Quercus macrocarpa* in relation to the invasion of prairie. Bot. Gaz. **94**: 51–85. *f. 1–10.* 5 O 1932.

Weier, T. E. The structure of the bryophyte plastid with reference to the Golgi apparatus. Am. Jour. Bot. **19**: 659–672. *pl. 46, 47.* 31 O 1932.

Weindlung, R. *Trichoderma lignorum* as a parasite of other soil fungi. Phytopathology **22**: 837–845. *f. 1–4.* O 1932.

Welch, W. H. An ecological study of the bald cypress in Indiana. Proc. Indiana Acad. Sci. **41**: 207–213. *f. 1–5.* 1932.

Wellman, F. L. Celery mosaic control in Florida by eradication of the wild host *Commelina nudiflora*. Science II. **76**: 390–391. 28 O 1932.

Wellman, F. L. *Rhizoctonia* bottom rot and head rot of cabbage. Jour. Agr. Res. **45**: 461–469. *f. 1, 2.* 15 O 1932.

Wherry, E. T. Range-extensions and other observations, 1931–32. Am. Fern Jour. **22**: 79–86. *pl. 5, 6.* Jl-S 1932.

Whetzel, H. H., & Drayton, F. L. A new species of *Botrytis* on rhizomatous Iris. Mycologia **24**: 469–476. *pl. 15, 16+f. 1.* 1 N 1932.

Wiggins, I. L. The pteridophytes of San Diego County, California. Am. Fern Jour. **22**: 87–93. Jl-S 1932.

Williams, H. F. Absorption of water by the leaves of common mesophytes. Jour. Elisha Mitchell Sci. Soc. **48**: 83–100. *pl. 4, 5.* O 1932.

Wilcoxon, F., & McCallan, S. E. A. The fungicidal action of sulphur. IV. Comparative toxicity of sulphur, selenium, and tellurium. Contr. Boyce Thompson Inst. **4**: 415–424. *f. 1–6.* S 1932.

Wilson, L. R. The Two Creeks forest bed, Manitowoc County, Wisconsin. Trans Wisconsin Acad. Sci. **27**: 31–46. *f. 1–4.* 1932.

Winter, C. W. Vascular system of young plants of *Medicago sativa*. Bot. Gaz. **94**: 152–167. *f. 1–34.* 5 O 1932.

Wood, C. A. Some wild flowers from Swiss meadows and mountains. Smithsonian Inst. Ann. Rep. **1931**: 503–513. *pl. 1–6.* 1932.